FEASIBILITY STUDY FOR AN INFILL BART STATION
In San Francisco, at 30th & Mission Streets

Prepared for the Bay Area Rapid Transit District
by John T. Warren & Associates, Inc.

In Association with
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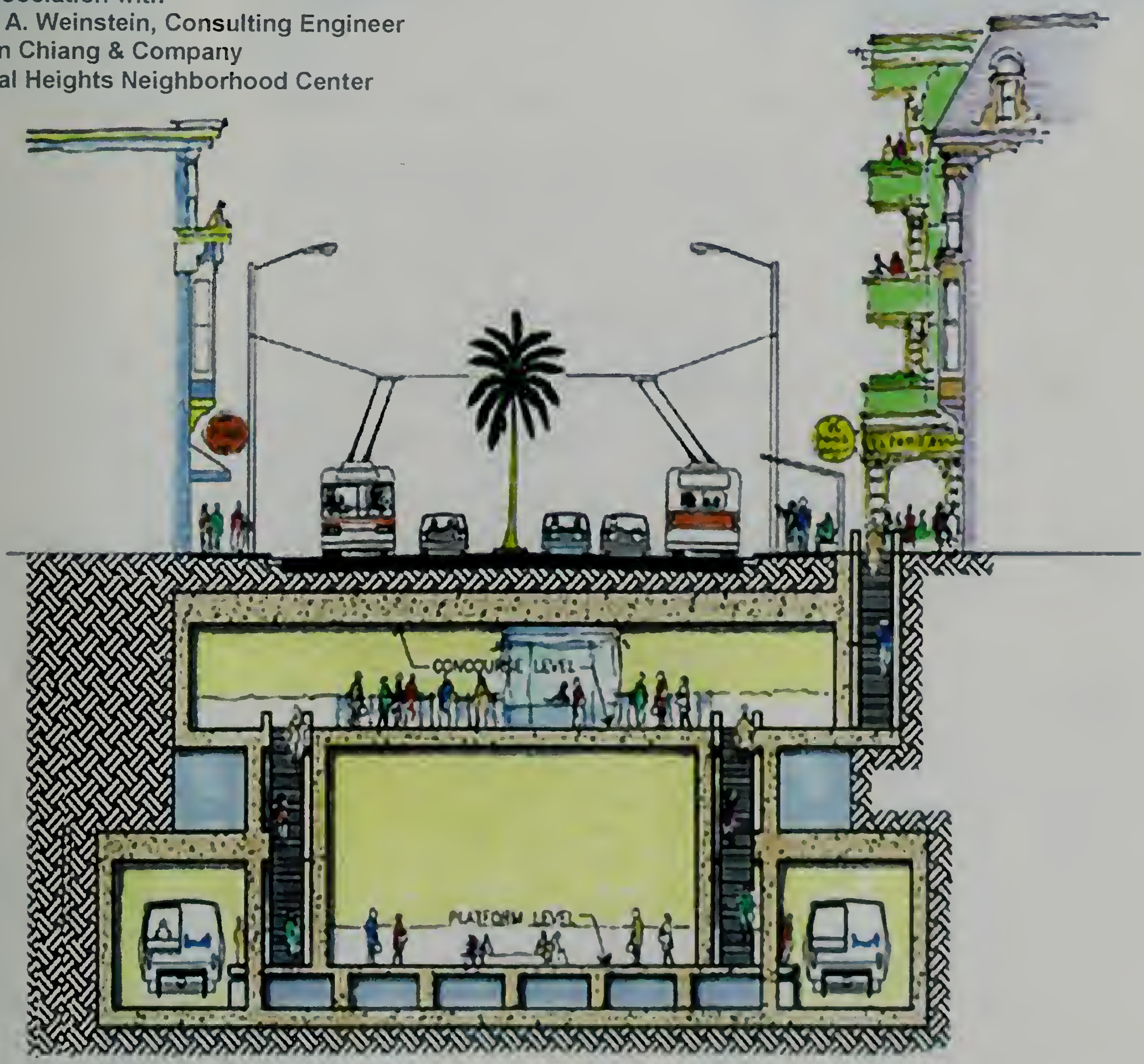
Bernal Heights Neighborhood Center



Final Report
MAY 2003

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JOHN T. WARREN & ASSOCIATES, INC.

FINAL REPORT

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Bay Area Rapid Transit District

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EXECUTIVE SUMMARY

Introduction

This study is intended to assess the feasibility of constructing a new Bay Area Rapid Transit (BART) Station on the existing BART Mission Street line between the existing stations at 24th Street and Glen Park. This study has been funded by an earmarked State grant of $400,000.

The scope of this technical study is limited to the engineering, construction impacts and costs, as well as operational factors involved in the development of a new infill station at 30th Street. The scope of the study does not include the potential for transit improvements other than a BART station. Nor does it address city or urban planning factors nor an assessment of the potential environmental impacts. The purpose of the study is to evaluate, not to advocate.

The original BART system was completed along the Mission Street Corridor in the late 1960's. Stations were constructed at 16th Street, 24th Street, and at Glen Park. More recently, the potential need for additional transit access in the area between the existing 24th Street and Glen Park Stations has been identified. The distance between the 24th Street and Glen Park Stations is the longest between any two adjacent San Francisco BART stations.

<u>Origins of the Concept</u>: *Director Tom Radulovich of BART had long been interested in the idea of a 30th Street infill station. In 1998, his idea prompted a review of ridership potential by the San Francisco County Transportation Authority for a new BART station at 30th and Mission, selected for its centrality, potential for joint-development, and immediate connections to several major MUNI bus and light rail lines. In 2000, Director Radulovich worked with California Assemblyperson Carole Migden (D-San Francisco) to secure a State budget grant to study the feasibility of this proposal in greater detail.*

<u>Neighborhood Context</u>: *By reducing the longest station gap in the San Francisco BART line, the new station would serve the Mission, Bernal Heights, Upper Noe Valley, Fairmont Heights and Glen Park neighborhoods. It would also generate new transit trips. In addition, the station could provide excellent connections between BART and several important MUNI routes. The 30th and Mission Street Station could also support the goals of the San Francisco housing and economic development programs.*

The project has won support from a broad range of neighborhood groups and individuals. San Francisco Supervisors Tom Ammiano and Mark Leno have endorsed the idea, as have the Upper Noe Neighbors, Bernal Heights Democratic Club, Noe Valley Democratic Club, and the Mission Merchants Association. Three public meetings have been held in the vicinity of the site.

BART Operational Improvements: *The possibility of a major construction project at this location along the BART line also affords an opportunity to make other physical improvements to BART fixed facilities that could be beneficial in supporting and improving BART operations. For example, construction of a 'pocket track' in conjunction with the station could provide a turnback for some trains and for storing disabled trains to permit more flexible operations.*

BART Policy on System Expansion: *Implementation of the 30th and Mission Street Station project would have to meet requirements of the new BART Policy on System Expansion.*

Existing Conditions

Existing BART Alignment: *The existing BART line in this vicinity is a twin track tunnel approximately 30-40 feet below street level. The proposed new station site is located along a segment of 3.12 per cent grade.*

Existing BART Operations: *Four of the five BART lines pass through the station site. Train headways (time intervals between trains) vary between 3.5 and 10 minutes, depending on time of day and day of the week. All trains that operate through the proposed site must also transit the Transbay Tube, which is the main capacity restraint in the BART system. Minimum train headway along this line is presently 2.5 minutes (24 trains per hour). However, BART is installing an Advanced Automatic Train Control (AATC) system that will result in reduction of the minimum headway and increase capacity. Existing BART ridership through this segment is about 130,000 passengers on each weekday.*

Existing Surface Street and Right-of-Way Conditions: *The proposed station site occupies a segment of Mission Street which extends from 30th Street/Eugenia Street on the south to 29th Street at the north. Mission Street is about 56 feet wide, curb to curb, accommodating four through–traffic lanes and curb parking.*

Buildings are from two to four stories high, mostly pre-World War II construction of commercial and residential use. However, there is one large modern four-story apartment building with street level commercial on the east side of Mission Street. A large Safeway parking lot occupies the west side of Mission Street just south of Virginia.

Existing MUNI Transit Service: *The San Francisco MUNI operates seven routes through the proposed station vicinity. Of note is the 14-Mission trolley bus, which provides local transit service generally above and parallel to the BART line along the entire Mission Street Corridor. The nearby J-Church light rail line on San Jose Avenue and Church Street is an alternative downtown rail transit route. The 24-Divisadero and 49-VanNess trolley buses are important crosstown routes.*

Applicable Project Guidelines & Design Criteria

The most important design criteria as they relate to a possible 30th Street Station are:

- Design Speed: *Maximum speed of 80 mph and 36 mph for track approaches near station platforms and through turnout (switches).*

- Track Gradient: *The maximum gradient for the track at platforms is 1.0 per cent.* ***This is a very important criterion, and it is a defining standard for this project.***
- Platform Gradient: *This is limited by the Americans with Disabilities Act (ADA) which requires that the platform be nominally level, but no more than 1.5 per cent.*
- Platform Length: *Shall be adequate for a ten-car train, about 700 feet*

Other BART Functional Criteria: *The following criteria relate to providing for certain needed functions of the proposed new facility:*

- Maintain Line Capacity: *The new station should not significantly degrade the capacity of the BART line.*
- Construction Impacts: *The construction of the new facility should not unduly hinder BART train operations during the course of the work.*
- Provide Mainline Bypass Track: *With a bypass track, some trains may not have to stop at the station. Accordingly, these trains would have a shorter travel time and provide better service to those passengers who do not need to use the new station. However, this would increase the wait time for those passengers that do wish to use the station. This issue introduces the concept of 'off-line' vs. 'on-line' platforms, which is addressed further for the specific alternatives.*
- Train Turnback: *A train turnback capability can be considered to permit reversal of revenue trains (trains carrying passengers) or for side-tracking of malfunctioning trains. However, the additional cost of such an adjunct should be considered separately from the basic station cost.*

Alternative Development

All potentially feasible alternatives need to be developed with a common philosophy and approach, and must have certain basic features in common:

1. Basic Station Configuration: *The new station must provide separate platform and mezzanine levels.*
2. Station Grade: ***The requirement to revise the track grade at the platforms from the existing 3.1 percent to a flatter 1.0 per cent obligates the design to include extensive reconstruction, including long approach tunnels, to provide the needed transition.*** *This results in a construction segment considerably longer and more costly than would have been the case if the grade-reduction problem did not exist.*
3. 'Off-Line' Construction: *Because the new tracks must be constructed on a different profile grade than the existing, the new tracks and platforms must be constructed separate from, and away from the existing tunnels.*
4. Merge of New Work into the Existing Tunnels: *At the extreme ends of the new tunnels and trackage these have to be connected into the existing tunnels and tracks. Much of the construction work at the four merge locations would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended.*

5. Operational Considerations: *The introduction of a new additional station on the line would result in an increase of travel times for all trains that stop at the station.*

Alternatives Considered: *A total of seven alternatives were originally developed and considered. In addition, an on-line alternative using the existing tunnels and tracks was also previously suggested. The latter concept is now considered infeasible. The two most promising alternatives were chosen by BART staff so as to best represent two fundamental objectives.* ***Alternative 'A' – On-Line Station with Optional Turnback*** *has been developed as a lowest-cost option.* ***Alternative 'B' –Off-Line Station with Full Turnback*** *has been developed as an option that could support optimum operations of the BART system.*

Alternative 'A' Description: On-Line Station with Optional Turnback (Least Cost Alternative):

This concept, as shown in Report Figure 5, involves construction of the new northbound and southbound station platforms and tracks on the outside flanks of the existing BART tunnels. The new station is planned on a 1.0 per cent grade and thus new approach tunnels are required to conform back to the existing tunnels on south end. In this scheme, the two BART tracks would be relocated to the new station and tunnels and there would be no other tracks provided. The center platform would extend across between the two tracks.

The basic scheme requires no track turnouts or junctions, however, a separate Option has been analyzed to provide a turnback pocket track to the south of the new station in the space between the two new main line tunnels. The purpose of the turnback would be to permit reversal of some revenue trains from the north and/or as a location to remove disabled trains from the main line.

Alternative 'A' Advantages:

- *Simplest track configuration and train operations*
- *All trains would stop at the new station*
- *A narrower mezzanine is needed than for Alternative 'B' thus reducing property impacts*
- *The single, wide center station platform is a passenger amenity*
- *The basic scheme does not include crossover tracks or turnouts, which would be disruptive to train service to construct*
- *An optional turnback track is possible at extra cost*
- *The basic scheme has marginally lower construction cost than Alternative 'B'*

Alternative 'A' Disadvantages:

- *The new station stop would reduce BART main line capacity*
- *New track curves may impose additional train speed restrictions*
- *Less operational flexibility than Alternative 'B' which permits train bypass of the station*
- *The optional turnback track is costly and is not easily accessible from the south*
- *The station platform level would need to be constructed in two stages*

Alternative 'B' Description - Off-Line Station with Full Turnback (Optimum BART Operations):

This scheme, shown in Report Figure 6, provides for new station platforms and tracks in addition to retaining the existing tracks and tunnels as a main line bypass. This Alternative also provides an operational option for turnback capability and/or disabled storage train. Many features are similar to Alternative 'A' but, unlike Alternative 'A', this alternative utilizes turnouts at all the tunnel merge locations so that trains approaching the station may either proceed to a stop at the platforms or bypass the station using the pre-existing tunnels and tracks.

This scheme could accommodate express trains that would bypass the station. This type of operation would improve speed and runtime of some trains and thus support higher line capacity. But if too many of the trains were express runs, service to the new station would be diminished. The double crossover north of the station could serve as a revenue turnback for trains to/from the north. However, the use of the center tracks for either turnback or storage conflicts with their possible function as bypass tracks. These different functions cannot occur at the same time.

Alternative 'B' Advantages:

- *Provides bypass tunnels facilitating express train operations*
- *Compared to Alternative 'A', minimizes capacity reduction in BART system*
- *No new restrictions on express train speed*
- *More flexibility in turnback operations and for sidetracking and holding trains*
- *The station platform construction could be completed in one stage*

Alternative "B" Disadvantages:

- *Greater operational complexity*
- *Potential for delay of trains reentering main line from the platform tracks*
- *All trains may not provide service to the station*
- *Express train turnback operations and disabled train storage are mutually exclusive uses of the second pair of tracks*
- *The turnback capability is available only to/from the north*
- *More complex trackwork, especially the crossovers, may increase service interruptions during construction*
- *More right-of-way needed than the basic Alternative 'A'*
- *Separate narrow platforms are less attractive for passenger use than a center platform, and need additional escalators and elevators resulting in higher operating costs*
- *The separate platforms might also be more confusing to use for passengers boarding or transferring to/from turnback trains.*
- *Slightly higher construction cost than Alternative 'A'*

Right-of-Way and Construction Impacts

The station consisting of the mezzanine and most of the platform area is too large to be tunneled or excavated out exclusively from below. Instead, open pit excavations would be needed for

most of the station box construction. These pit areas, which would be temporarily decked over, would also provide ingress for construction and egress for removal of excavated earth material.

Right-of-Way: *The 'footprint' of the station and its tunnel approaches extend beyond the right-of-way lines on both the east and west sides of Mission Street. Because much of the property frontage on the west side of the street is occupied by a Safeway parking lot, the station layout should favor right-of-way takes along the west side. The Safeway lot could then be rebuilt after project completion. However, some buildings on both the east and west sides would be demolished. Some tunnel segments of the work, due to their depth, might be completed beneath existing buildings without disturbing them.*

Areas of Open Excavation: *Three or four excavation pits would be required. The other station segments might be tunneled from below in order to save property impacts and buildings. The main pit would be excavated at the location of the station mezzanine. It would be located in the vicinity of Virgina Avenue and Godeus Street, at the Safeway parking lot. A second excavation would be located between 29th Street and Valencia Street, to the north of the main pit. The third excavation would be needed only for the Alternative 'A' option that includes the pocket track ('wishbone') connections. It would be located just south of the main pit. The fourth excavation pit would be further to the south, in the south quadrant of the Chenery Street/Miguel Street intersection. This site would provide for construction of the south tunnel-merge structures.*

Property Acquisition: *The approximate number of properties likely to be taken vary from about 23 for the basic Alternative 'A' to 32 for the Alternative 'A' option with a pocket track. In addition, there would be numerous buildings along Mission Street and above the south approach tunnels that would not be physically disturbed, but would be tunneled beneath within a subsurface right-of-way easement.*

Construction Impacts: *The station box structures, which would accommodate the station platform and mezzanine and also the north tunnel-merge structures, would have to be constructed by cut-and-cover means. Due to the extreme depth of the southerly tunnel-merge location, excavation of the large pit all the way down from the surface there might not be feasible or desirable. If such is the case, the underground excavation would need to be accomplished working mostly from below.*

Staging and Sequencing: *First, utilities would be relocated. In the next stage special 'soil mix' walls would be drilled along the street. Then a temporary deck would be constructed along one half of Mission Street while two lanes of traffic are rerouted onto the other half of the street. Excavation would proceed below. After traffic can be redirected onto the completed temporary decking, the second half of the street would be drilled and decked. The excavation could then proceed to completion beneath the full-width temporary decking, and at that time, all four traffic lanes could be restored to Mission Street. After the excavation had reached its full depth, the station box structure would be constructed.*

Tunneling and 'Cut-In' to the Existing Tunnels: *The bored tunnels would be constructed from below grade so that the surface could remain undisturbed. At the extreme ends of the new tunnels and trackage, these would have to be connected into the existing tunnels. The merge construction of the project is highly problematic as it involves potential interruption of train*

traffic and single-tracking of train service while the work proceeds. Much of the construction work at the merge locations would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended.

Track Construction: *Construction of the trackwork and its foundations at the 'cut-in' locations would also be especially difficult, accomplished by three possible means:*

1. Modify Track Slab Fixation: *This would be the preferred approach. New fasteners would be slipped under the existing rails and bolted onto the supported concrete. Initially, the new fasteners would be adjusted to support the existing rails. Then the pre-existing rail fasteners would be removed and the new fasteners quickly readjusted the new rail fittings.*
2. Use of 'Boot-Ties': *These could be used in some locations in lieu of the special new fasteners.*
3. Conventional Switch Ties: *Ties could be inserted one-by-one from the side of the track. However, a major disadvantage of this approach is the greater depth needed in cutting out the base slab. Either timber or concrete ties could be utilized.*

With any of these methods, all of the proper tie plates and fasteners to support each turnout would have been installed during a preparatory phase during numerous evening/night time service-interruption windows, which would involve single-track operations. Completion of the trackwork for insertion of the new segments of rail would require weekend-long service interruptions.

Surface Traffic Detouring and MUNI Routes: *During almost all of the construction period, vehicular traffic, including all MUNI bus routes, could be maintained on the surface of Mission Street on a temporary deck. However, during initial temporary deck construction and again during its removal, traffic would have to be restricted to only two lanes, one in each direction. On-street parking would have to be prohibited during the entire course of construction in order to free up room for construction vehicles. All MUNI bus routes, including the electric trolley buses, could be kept operating over the temporarily decked street at almost all stages of construction.*

Construction Schedule: *The general sequencing would be similar for Alternatives 'A' and 'B'. The total time requirement from inception of construction to completion would be about three and a half years.*

High-Risk Construction Issues: *This project involves many unusual and difficult operations that entail risk. The meaning of risk is that there is a reasonable probability that unforeseen problems may arise or that foreseen problems might become more problematic than originally expected. Such factors include the possibility and increased potential for hazard during underground construction in constrained areas, and for construction near an operating rail system. To address these potential problems, all construction operations must be undertaken with utmost caution, with the most conservative safety measures fully enforced. In addition, costly special insurance policies might be warranted.*

Maintenance of BART Service During Construction

Useful construction windows cannot be provided during regular nighttime service suspension. Instead, construction on the tracks must involve reductions in revenue train service and single-tracking operations. Although it is possible in theory to set up substitute bus service ('bus-bridges'), there are serious deficiencies to that approach.

Therefore the option of single-tracking is the only remaining possibility; one of the two BART tracks is shut down for construction while trains from both directions take turns using the remaining track. This would impose considerable delay and inconvenience on patrons. It is not feasible to operate more than one line over the single track. Therefore, one of the two lines (such as operate on Sundays) would have to be turned back at each end of the single-track segment.

It might be possible to supplement the single-track service with a bus-bridge or possibly with augmented parallel MUNI and/or Caltrain service. However, these are not sufficient alone to completely replace BART service. Substitute bus service was considered as a alternative, but was not found to be adequate.

Operations Qualitative Review

The following are the benefits and drawbacks of each Alternative:

Alternative 'A' – Benefits:

- *The basic scheme has no switching, thus there is no additional delay created by merging revenue trains.*
- *See below for benefits of turnback option.*

Alternative 'A'- Drawbacks:

- *This scheme requires all trains to stop at 30th Street and so lengthens end-to-end runtimes for all routes. This might require additional revenue vehicles to maintain headways.*
- *All trains stopping at 30th Street would have to stop on a main line track, thus significantly reducing line capacity in both directions.*

Alternative 'B' – Benefits:

- *Permits 'skip-stop' (express) operation past 30th Street.*
- *Compared to Alternative 'A', this scheme provides a four-track segment that has improved potential for delay mitigation.*

Alternative 'B' - Drawbacks:

- *There is a potential for very long station dwell during the peak period for those trains that stop at the platforms and having to wait for a 'gap in the bypass track schedule.*
- *With very close headways and the potential train interactions, any delays or 'off-set' in timing for diverted trains to merge back onto main line, may result in reduced capacity.*

Alternative 'A' includes a turnback pocket track as an extra-cost Option. Alternative 'B' does not include a special turnback track, but would permit use of the two center bypass tracks for turnback as an operational option. If the center track were to be used for turnback/storage

function, it could not be simultaneously available as a bypass/express track. There are also two types of turnback use – One for reversing revenue trains, and a second for storage and reversing of disabled trains.

Alternatives 'A' and 'B' Turnback Track – Benefits:

- *Operational flexibility by allowing revenue trains to turn back at 30th Street, out of the way of main line traffic.*
- *Depending on the schedule, there may be the ability to reduce the need for rolling stock.*
- *Capability to temporarily store disabled trains on the center track(s), out of the way of mainline traffic.*

Alternatives 'A' and 'B' Turnback Track – Drawbacks:

- *Operational complexity requires merging of trains leaving the pocket track into the main line.*
- *For revenue turnback, trains would require three separate dwells (stop and starts).*
- *The three possible uses of the center tracks of Alternative 'B' – (express trains, revenue train turnback and disabled train storage) are mutually exclusive at the same time.*
- *The 3.21 per cent grade of the center tracks in Alternative 'B' is disadvantageous for their most effective use for train turnback and storage.*
- *Construction of the Alternative 'B' double crossover tacks on the existing mainline could disrupt train operations.*

Capacity Review

Two separate analyses were undertaken by BART staff to address system capacity. These include a headway simulation and a line capacity review:

Analysis of train operations with and without a 30th Street Station was conducted by BART staff. A computer simulation was utilized based on operating assumptions with the objective to define train headways as the major index of system capacity 'thruput'. Conclusions of the simulation clearly describe a degradation of BART line-haul services if a 30th Street station is implemented. The simulation shows that the addition of a new station would set back BART operations to a condition similar to that which prevailed before implementation of the new AATC system.

In addition, a line capacity review was conducted to assess the impacts on Transbay capacity of adding an infill station. This additional analysis approached the 'thruput' problem by determining the magnitude of excess capacity of the Transbay line. It was then assumed that any such excess capacity would be available to serve the needed extra service demand of a new 30th Street Station. The analysis focused on estimating the available line capacity sufficient to meet Transbay demand during am and pm peak hour, peak direction, as these are the periods during which rolling stock and resources are taxed to the maximum.

Significant eastbound line capacity for FY2020 may be available west of the major downtown stations, however this capacity is needed to satisfy Transbay demand and, therefore, should be reserved to meet the greatest demand at the maximum load point station, which is Embarcadero. Thus, eastbound Transbay traffic generated by the 30th Street Station, while assumed to be low,

would have detrimental impact on line capacity to the Eastbay, if it were to exceed the available Transbay capacity.

Therefore both the simulation analysis as well as the line capacity review were in agreement that any additional traffic generated by a 30th Street Station, or any other infill station on the line, would be a detriment to BART system line capacity.

Ridership

The 1998 ridership projections by the San Francisco County Transportation Authority that showed between 3,700 to 5,000 riders using the 30th Street Station, did not anticipate the opening of the BART extension south of Colma nor include riders using BART to reach San Francisco International Airport or Millbrae and the Caltrain connection to points south. In addition, land use changes since that time and as proposed for the future by the City of San Francisco were not addressed.

Currently, the San Francisco Planning Department and various neighborhood groups are planning to revisit zoning, land use and housing changes in the immediate vicinity of 30th and Mission. The outcome of these efforts would be essential in establishing the full magnitude of ridership and benefits of any new station there.

Intermodal Considerations

BART/MUNI Transfer: *The service impact of a new BART station would generally occur in one of three ways relating to the existing MUNI routes:*

1. *Those MUNI routes that run approximately parallel to the BART line, (14, 14L, 26, 29 and 'J') and that already serve other existing BART stations, would be expected to lose only a very small amount of patronage to BART.*

2. *For a crosstown MUNI route such as the 24-Divisadero, which presently does not serve any BART station, it would be expected that related transfer ridership would increase on both MUNI and BART. Indeed, a transfer between BART and the 24-Divisadero would be the greatest single intermodal improvement of the proposed project. The Hunter's Point connection of the 24-line would be the most significant.*

3. *For a local shuttle route such as the 67-Bernal Heights line, which already serves another BART station at 24th Street, it would be unlikely that a new 30th Street Station would have great impact on ridership.*

Parking: *The objectives of this project do not include provision of BART station parking. Parking impacts of a new station would be limited to that resulting from surface street modifications needed to construct the new station.*

Handicapped Access: *With respect to ADA and handicapped patron transfer to MUNI at a new 30th Street BART Station, it is expected that few special facilities would be needed on the surface*

of Mission Street. There would be a slight improvement to handicapped transit access due to improved interconnectivity and access to the fully accessible BART system.

Cost Estimates

	Alternative 'A' On-Line Station *Basic*	Alternative 'A' *with Pocket Track*	Alternative 'B' Off-Line Station
Construction Cost:	**$261,261,000**	**$309,183,000**	**$271,133,000**
Contingencies @ 25%	65,315,000	77,296,000	67,783,000
Administration, Engineering and Operations ('Soft Costs')	117,567,000	139,132,000	122,010,000
TOTAL Project Facilities Construction:	**$444,143,000**	**$525,611,000**	**$460,926,000**

Right-of-way and certain other costs are not included in the estimates.

Conclusions

This study concludes with the following findings:

- *The three evaluated Alternatives are each basically feasible*
- *All the Alternatives are very costly projects*
- *The defining track gradient limitation of one percent (compared to the existing grade of 3.12 percent) is a major influencing factor that drives up the cost for a project of this type*
- *The Alternative 'A' basic scheme is least costly*
- *The Alternative 'A' scheme with a Pocket Track Option is most expensive*
- *Alternative 'B' includes the most important benefits and is only marginally more expensive than the lesser-cost Alternative 'A'*
- *This would be a very difficult and risky project to construct*
- *Property and business disruption impacts would be substantial*
- *Constriction traffic impacts would be significant, but subject to mitigation*
- *Local access to regional transit via BART at 30th Street would be greatly improved*
- *Station ridership potential has been estimated at 3,700 to 5,000 users, but newly-developing factors could result in more users, and further study is called for*
- *Alternative 'B' offers superior operational flexibility and means to recover from delay.*
- *Alternative 'A' is not as operationally beneficial as Alternative 'B'*
- *A 30th Street Station may contribute to limited capacity constraints at 24th and 16th Street Stations*

- *With Alternative 'A' train headways would be increased by up to 49 per cent with corresponding reduction in line capacity*
- *With either of the two Alternatives, there will probably be sufficient am peak hour capacity in the southbound/westbound direction*
- *New northbound/eastbound traffic generated at a 30th Street Station would limit the critical pm peak hour eastbound Transbay capacity by FY2020*
- *Operational benefits of a turnback can be provided, but only at extra cost*
- *Improvements to MUNI transfer and local transit would be minimal*
- *The 24-Divisadero MUNI line would benefit the most by the station*
- *Transit choices and handicapped access would be improved*
- *The potential for neighborhood beneficial improvements might be substantial, but evaluation of these are beyond the scope of this study*
- *The potential for joint development would be important, but evaluation of this is beyond the scope of this study*

Next Steps

- *Circulation, review and acceptance of this report*
- *Designation of a sponsoring agency*
- *Appointment of administrative staff*
- *Selection of oversight committees for policy and technical direction*
- *Establishment of ongoing lines of communication to other affected agencies*
- *Initiation of a community planning effort:*
  - *Updating of ridership projections*
  - *Improvement in definition of the alternative designs*
  - *Undertaking of focused technical and property studies*
  - *Refinement of cost estimates*
  - *Encouragement of companion studies for related neighborhood improvements and for possible joint development*
  - *Preparation of fully detailed cost/benefit studies*

FINAL REPORT

Bay Area Rapid Transit District

FEASIBILITY STUDY FOR AN INFILL BART STATION

In San Francisco, at 30th & Mission Streets

1. INTRODUCTION

This study is intended to assess the feasibility of constructing a new Bay Area Rapid Transit (BART) Station on the existing BART Mission Street line between the existing stations at 24th Street and Glen Park. Figure 1 shows the location of the proposed new station.

The scope of this technical study is limited to the engineering and construction impacts as well as operational factors involved in the development of a new 'infill' station at 30th Street. The study also provides an initial assessment of potential costs and possible benefits of such a station, a train operations simulation analysis, as well as a review of passenger ridership/capacity factors.

The scope of the study does not include the potential for transit improvements other than a BART station. Nor does it address city or urban planning factors which may relate to such a station, nor an assessment of the potential environmental impacts.

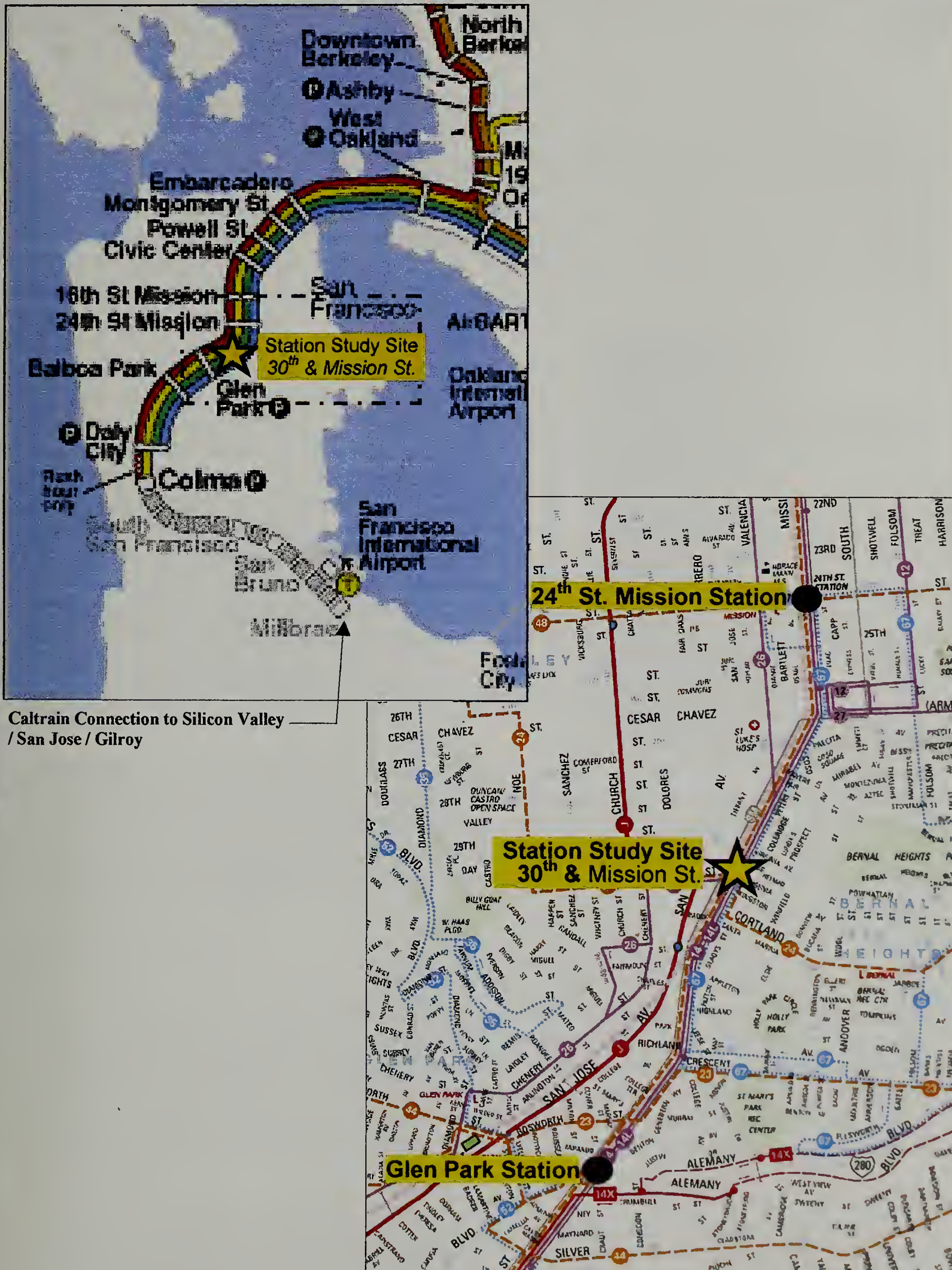
What is this Study? (and what is it not?)

- Study does not advocate a station
- Feasibility, not Preliminary Engineering
  - Is it possible?
  - Define range of alternatives
- Gather Data and Report Findings
- Anticipate Next Steps

Specifically, the scope of the present technical study includes:

- Investigation of the feasibility of the infill station concept, given track grade and other site constraints on the engineering
- An assessment of construction impacts on the surrounding neighborhood and on the existing BART system
- Review of operational issues including the benefits of construction of an optional pocket track at this site
- An analysis of current and future local transit connections and impacts associated with development of a station
- Review of capacity/ridership issues

This study has been funded by an earmarked State grant of $400,000.



FOR STUDY PURPOSES ONLY

FIGURE 1
30TH & MISSION BART INFILL STATION STUDY

Background and Need

The original BART system was completed along the Mission Street Corridor in the late 1960's. Stations were constructed at 16th Street, 24th Street, and at Bosworth and Diamond Streets in Glen Park. The original selection of station locations was based upon cost and operational factors as well as consideration of neighborhood benefits. Even at the onset of the original BART planning, it was fully intended that the BART project have a beneficial impact on the Mission Street neighborhoods by promoting their economic development, as well as improved transit access.

More recently, the potential need for additional transit access in the area between the existing 24th Street and Glen Park Stations has been identified. The distance between the 24th Street and Glen Park Stations is about 8,500 feet, which is the longest distance between any two adjacent San Francisco BART stations. (This compares, for example, with spacing of only 2,000 feet between the Montgomery and Embarcadero Stations, which are the most closely spaced stations on the BART system). This distance results in pedestrian access from the 30th Street vicinity to the existing stations being less convenient than elsewhere. Also discouraging easy pedestrian access to BART is the hilly topography, especially in the southern direction toward Glen Park.

Why This Location?

- Transit Connections to four MUNI bus lines and J-Church MUNI Metro
- Mid-point of large gap on BART line in San Francisco
- Serves five neighborhoods not directly served by BART: Bernal Heights, Outer Noe Valley, Fairmount and Outer Mission

The confluence of improved local transit connections, possible improved BART operational features and the potential for joint development have formed the impetus to conduct this study. A new BART station at 30th and Mission Streets would be the first new BART station in San Francisco since the completion of the Embarcadero Station in the mid-1970's. It would also be amongst only a few infill stations (together with the proposed West Dublin/Pleasanton Station) considered since that time.

Origins of the Concept

Director Tom Radulovich of BART had long been interested in the idea of a 30th Street infill station. In 1998, his idea prompted a review of ridership potential by the San Francisco County Transportation Authority for a new BART station at 30th and Mission, selected for its centrality, potential for joint-development, and immediate connections to several major MUNI bus and light rail lines. In 2000, Director Radulovich worked with California Assemblywoman Carole Migden (D-San Francisco) to secure a State budget grant to study the feasibility of this proposal in greater detail.

In order to submit the funding application together with Assemblywoman Migden, Director Radulovich requested that BART staff delineate a schematic plan for the station. This plan included a 'pocket' track that would enable disabled BART trains to be removed from revenue

service and turned back in the opposite direction. The original concept plan also included a simple pair of platforms parallel to the tracks, with a mezzanine located directly above them. This scenario was only illustrative, however, it formed the basis for the full feasibility review for which the funds were appropriated.

Because future ridership projections need to include consideration of existing and future land use conditions, the San Francisco Planning Department has been interested in undertaking an effort to review the Mission Corridor for development potential of high-density, mixed use projects. While the 30th Street and Mission location was considered for such land uses, the Planning Department had lacked the funding and resources to pursue a more intensive look at when and how such development might be encouraged.

Accordingly, in June of 2000, under the leadership of Assemblywoman Carole Migden, as Chairperson of the Assembly Appropriations Committee, $400,000 in State budget funds was earmarked to study a BART station at 30th and Mission Streets.

Neighborhood Context

By reducing the longest station gap in the San Francisco BART line, the new station would serve the Mission, Bernal Heights, Upper Noe Valley, Fairmont Heights and Glen Park neighborhoods. It would also generate new transit trips. In addition, the station could provide excellent connections between BART and several important MUNI routes, including the J-Church, 14-Mission, 24-Divisadero, 26-Valencia, 49-Van Ness, and 67-Bernal Heights lines. It could also reduce some of the passenger load on MUNI and possibly obviate the need for expanded service on some MUNI routes that feed BART.

The 30th and Mission Street Station could also support the goals of the San Francisco housing and economic development programs. The area surrounding the station has many potential sites for infill housing including vacant lots and underutilized locations which might be beneficially redeveloped with compatible uses. The project would offer a chance to reshape the Mission corridor in the vicinity of 30th Street, now dominated by a gas station, a Walgreen's, and a Safeway. The station could also present an opportunity to develop a comprehensive neighborhood plan, incorporate housing, neighborhood economic development, and make other traffic, transit, and pedestrian improvements. The station could provide better transit service to the Cortland Avenue, Mission Street, and Church Street neighborhood commercial districts.

The 30th Street Station could also support economic development of the Bayview-Hunters Point commercial district and the redevelopment of the Hunters Point Shipyard, by providing the regional transit connection for these areas via the San Francisco Municipal Railway (MUNI) 24-Divisadero trolley bus line.

The project has won support from a broad range of neighborhood groups and individuals. San Francisco Supervisors Tom Ammiano and Mark Leno have endorsed the idea, as have the Upper Noe Neighbors, Bernal Heights Democratic Club, Noe Valley Democratic Club, and the Mission Merchants Association.

Community Process

The study process has been intended as a means to elicit community response and input. Three community meetings were co-hosted by BART together with the Bernal Heights Neighborhood Center to describe the process for the feasibility study, and to solicit community input. The meetings were attended by residents of the Mission, Noe Valley, Bernal Heights and Fairmount neighborhoods, local merchants and representatives of City of San Francisco agencies, including MUNI, Parking and Traffic and the San Francisco Police Department. The first meeting was held in November 2000, in which the project was described and input collected on how BART might devise and refine alternatives for review.

A major aspect of the community process was to establish project goals and objectives. For example, amongst important community objectives was that BART service not deteriorate below existing levels of access and frequency north of 24th Street and south of Glen Park, as a result of the 30th Street Station project. The community also clearly wished a station that was not a terminus on a line stub, but rather that direct main-line BART access to both the northbound and southbound directions would be available. These objectives were set at both the first and second meetings, and were later used to constrain the alternatives.

The second meeting, which was held in November 2001, (after BART received the State grant appropriation) reviewed several possible alternatives for a station configuration. It also was a forum for discussion of basic technical requirements. Amongst these were those factors BART engineers must consider in order to assess the feasibility of alternatives. At the meeting, BART staff presented the two Alternatives (described in detail in a following section) that were advanced for more intensive review. This included attention to operational factors and identification of impacts on the entire BART system associated with the construction of this station.

A third community meeting was held in April 2002 at which BART staff described construction phasing, construction costs and the need to develop community consensus in order to proceed with an implementation program.

The community meetings have also been a forum which participants have utilized to promote the project. Dave Monks, President of the Noe Valley Democratic Club and a leading advocate of the station, was pleased with progress. Said Mr. Monks, *"This funding is a welcome surprise. We're on the transportation radar now, and it will be up to surrounding community groups to come together, follow the project, and make sure we turn out at meetings where the big decisions get made. It's great to see creative thinking and community support win the day."* Project opponents were also given an early opportunity by this process to make their position known or to state their preferences.

At the third community meeting, there was continued strong support amongst attendees for the station concept. However, stated concerns included the need for property takes that would reduce the housing supply and about the potential for security problems around such a station.

BART Operational Improvements

Potential System Benefits:

- Increase in operational flexibility
- Train turnback potential
- Enhancement to failure management / recovery
- Increase ridership

The possibility of a major construction project at this location along the BART line also affords an opportunity to make other physical improvements to BART fixed facilities that could be beneficial in supporting and improving BART operations. For example, construction of a 'pocket track' in conjunction with the station could provide a turnback for northbound and/or southbound trains. A new pocket track for storing disabled trains would permit more flexible operations and quicker recovery from system delays. Thus a new station, in combination with a new pocket track, could result in operating cost savings.

Operational factors also need to be considered in context with the soon-to-be-opened south extension of BART to San Francisco International Airport (SFO), and the Caltrain transfer station in Millbrae.

Summary of Goals and Objectives

Primary Objectives:

- Improve regional transit access and increase regional and local ridership
- Improve pedestrian access to transit
- Improve local transit connections to BART
- Maintain BART line capacity and train frequency
- Provide convenient local access to all BART destinations
- Provide impetus for neighborhood housing and economic improvements

Secondary Objectives:

- Provide neighborhood amenity
- Improve BART operations by addition of new track turnbacks
- Improve surface transportation features
- Limit construction and operating costs
- Minimize right-of-way impacts
- Minimize construction impacts

BART Policy on System Expansion

The ultimate implementation of the 30th and Mission Street Station project would have to meet requirements of the new BART Policy on System Expansion. A copy of the "*System Expansion Criteria and Process*" policy is included in Appendix 'A'.

The BART Board of Directors first adopted a Policy Framework for System Expansion on December 2, 1999, and directed BART staff to undertake its full development. This was to include conduct of subregional stakeholder outreach, and completion of a detailed policy for Board review and approval to guide the identification, prioritization and phasing of system expansion opportunities. The detailed policy was completed and was adopted by the Board on December 5, 2002.

This process has included a systemwide strategic expansion opportunities assessment to address proposed Extension Staging Policy projects and other expansion projects that may have significant potential. It considered a range of opportunities (i.e. possible project phasing) that might include interim service options and be completed through local partnership with the communities that would be served. Staff also sought to identify and analyze the issues and alternatives the District would need to consider in developing institutional and financial arrangements to support system expansion.

Policy Framework Goals for System Expansion:

1. Enhance regional mobility, especially access to jobs
2. Generate new ridership on a cost-effective basis
3. Demonstrate a commitment to transit-supportive growth and development
4. Enhance multi-modal access to the BART system
5. Develop projects in partnership with communities that will be served
6. Implement and operate technology-appropriate service
7. Assure that all projects address the needs of District residents

Strategies to be Utilized by BART in Pursuing System Expansion:

1. *Partnerships*: Seek partnerships with other agencies, local communities and private entities to plan and implement service expansion
2. *Transit Service Options*: Explore new BART and other transit service technologies (i.e., commuter rail, light rail, quality bus) where appropriate and possibly as interim services.

3. *Criteria for Project Advancement*: For all new expansion projects (new extensions, new in-fill stations) develop criteria that will assure that projects are:
   - Cost effective, (i.e., minimize the need for operating subsidies)
   - Integrated with other services and facilities in an intermodal regional network
   - Able to maximize ridership by supporting smart, efficient and desirable growth patterns
   - Accommodated without adversely affecting existing system capacity, quality and financial health
   - Adequate for bus, bicycle and pedestrian feeder service

2. EXISTING CONDITIONS

BART Facilities

The existing BART line in this vicinity, as illustrated in Figure 2, is a twin track tunnel approximately 30-40 feet below street level. These tunnels were constructed by boring from below, without disruption of the ground surface. The tunnel cross section south of 24th Street Station is circular, with the two tunnels separated by about 20 feet, and consisting of 18-foot diameter bolted steel tunnel segment rings, with a poured (direct fixation) concrete trackbed. North of Glen Park Station the cross section is a bored concrete tunnel of circular cross-section. The BART running rails are directly bolted to the concrete tunnel invert without ties or ballast.

The horizontal alignment in this segment between 24th Street and Glen Park Stations consists of a 'broken back' curve (two curves separated by a straight tangent) with radii of about 1,400 feet and 2,700 feet, respectively from north to south. The intermediate tangent between the two curves through the proposed new station site is about 2,500 feet long. The design speed of the curves is similar to that of most of the BART system main line, about 80 mph.

The vertical alignment in the segment includes a short sag curve just south of the 24th Street Station, leading to sustained grades of 3.12 per cent and then 0.67 per cent up to Glen Park Station. The net difference in elevation between track levels at 24th Street and Glen Park Stations is about 110 feet. The proposed new station site is located along the segment of the 3.12 per cent grade.

There are vertical vent shafts connecting the BART tunnels with the surface in the vicinity of Valencia Street and San Jose Avenue.

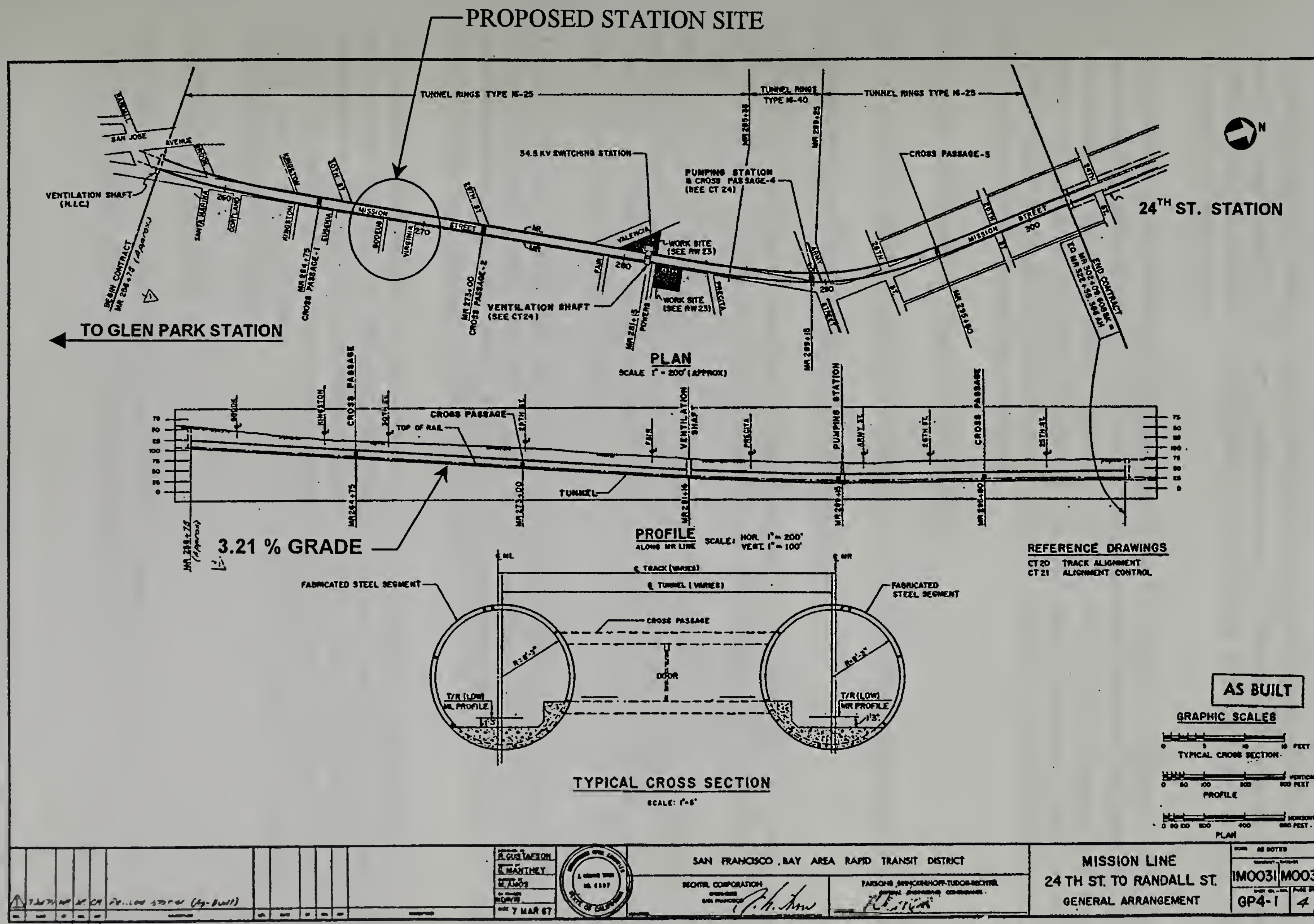
Existing BART Operations

Four of the five BART lines (all the lines except the Richmond-Fremont Line) pass through the station site, and thus all BART destinations can be reached from this location without transfer. (Except Saturday evenings and Sundays, when only two lines operate.)

BART Line Headways (minutes)

	Richmond	Pittsburg/Bay Point	Fremont	Dublin/Pleasanton	All
Weekday Peak	15	10	15	15	3.5
Mid-Weekday	15	15	15	15	4
Weekday Evening	*	20	*	20	10
Saturday	20	20	20	20	5
Saturday Evening	**	20	**	20	10
Sunday	--	20	--	20	10
Sunday Evening	--	20	--	20	10

*No service after 7:30 pm
**No service after 7:00 pm



BART EXISTING CONDITIONS

FOR STUDY PURPOSES ONLY

FIGURE 2
30th & MISSION BART INFILL STATION STUDY

FIGURE 2

Highest train speed is about 70 mph between the existing 24th Street and Glen Park Stations. The trains are programmed for 50 mph speeds south of 24th Street Station, with the 70 mph speed north of Glen Park Station. Train headways (time intervals between trains) are approximately as indicated in the table above.

All trains that operate through the proposed site must also transit the Transbay Tube, which is the main capacity restraint in the BART system. Minimum train headway along this line is presently 2.5 minutes (24 trains per hour). However, BART is committed to a program of train control system improvements including conversion to an Advanced Automatic Train Control (AATC) system which will result in reduction of the minimum headway. Train control features are more fully addressed in the Section on Operations.

Maximum train length is 10 cars, or about 700 feet.

Existing BART ridership through this segment is about 130,000 passengers on each weekday.

Existing Surface Street and Right-of-Way Conditions

The proposed station site occupies a segment of Mission Street right-of-way which extends from 30th Street/Eugenia Street on the south past Godeus and Virginia Streets north to 29th Street.

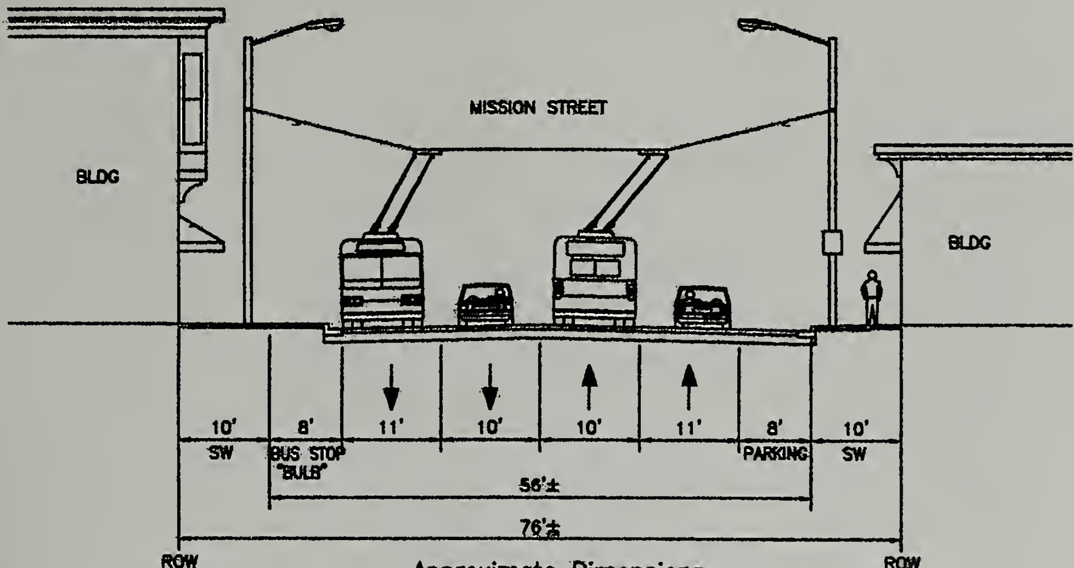
Mission Street is a main arterial street about 58 feet wide, curb to curb. As shown in Figure 3, it accommodates four through–traffic lanes as well as parallel curb parking on both the east and west sides. There are no turning lanes north of San Jose Avenue. Traffic signals exist at 29th Street, Virginia Street and 30th Street.

Lane widths are generally less than the 12-foot national standards, from 10 to 11 feet in width. Sidewalk widths on each side of the street range from about 10 to 12 feet. At bus stops, the sidewalks are widened into 'bulbs' with buses stopping in the right lane to load. A layout plan of the traffic lane configuration is included in Appendix 'B'.

The distance between building lines is about 78 feet, this also being the width of the City street and sidewalk right-of-way. Buildings are from two to four stories high, mostly pre-World War II construction of commercial and residential use. However, there is one large modern four-story apartment building with street level commercial (BigLots store) on the east side of Mission Street, north of Virginia Street. A large Safeway parking lot occupies the west side of Mission Street just south of Virginia.

Existing MUNI Transit Service

The San Francisco Municipal Railway (MUNI) operates the following routes, as shown in diagram of Figure 4-A, through the proposed station vicinity:



Approximate Dimensions
(Actual Dimensions Vary)

MISSION LOOKING SOUTH FROM VIRGINIA

MISSION LOOKING NORTH FROM KINGSTON

FIGURE 3
30th & MISSION INFILL STATION STUDY
John T. Warren & Associates, Inc.

FOR STUDY PURPOSES ONLY

Route No.	Type of Vehicle	Service Orientation	Peak Hour Headway
14-Mission*	Electric Trolley Bus	Downtown	5 minutes
14L-Mission*	Diesel Bus	Downtown Limited	9 minutes
24-Divisadero	Electric Trolley Bus	Crosstown	15 minutes
26-Valencia	Diesel Bus	Downtown	15 minutes
49-Van Ness*	Electric Trolley Bus	Crosstown	7 minutes
67-Bernal Heights*	Diesel Bus	Local Shuttle	20 minutes
J- Church *	Light Rail Transit	Downtown	6 minutes

* Presently connects directly to a BART station.

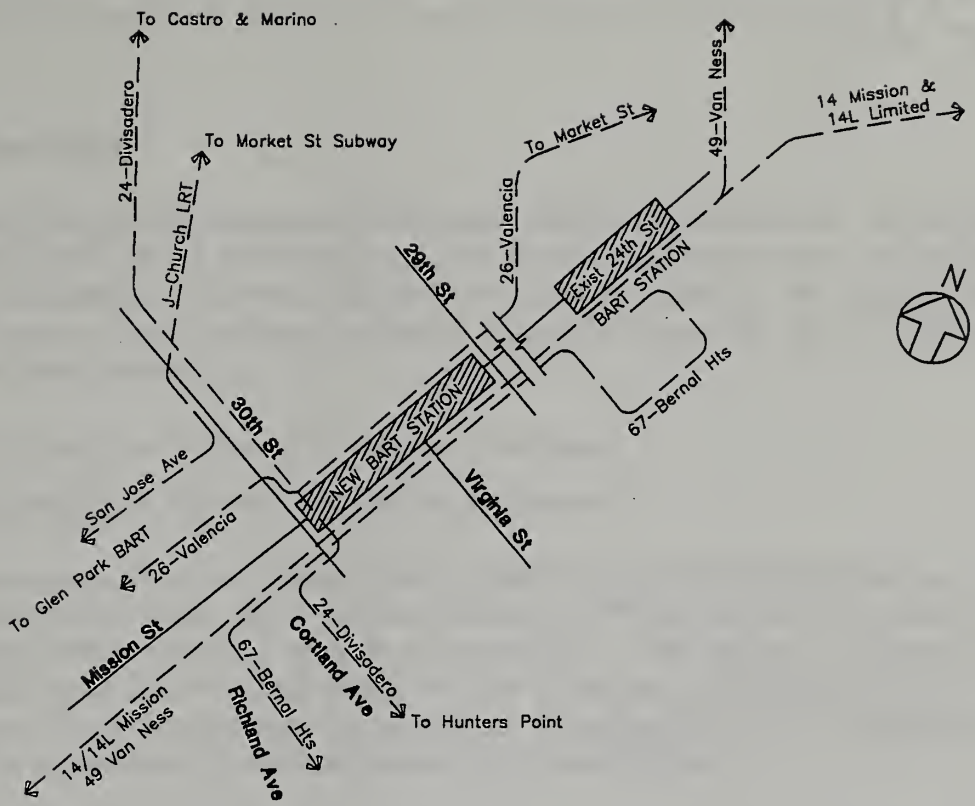
Daily boardings of selected MUNI lines were tabulated in 1998 for the boardings in the immediate area of the proposed new 30th Street Station, for the following routes:

- J-Church: 2,500 passengers
- 14-Mission: 2,300
- 24-Divisadero: 1,500 – 2,000
- 67-Bernal Heights: 2,500

TOTAL: 9,000 passengers (approximate)

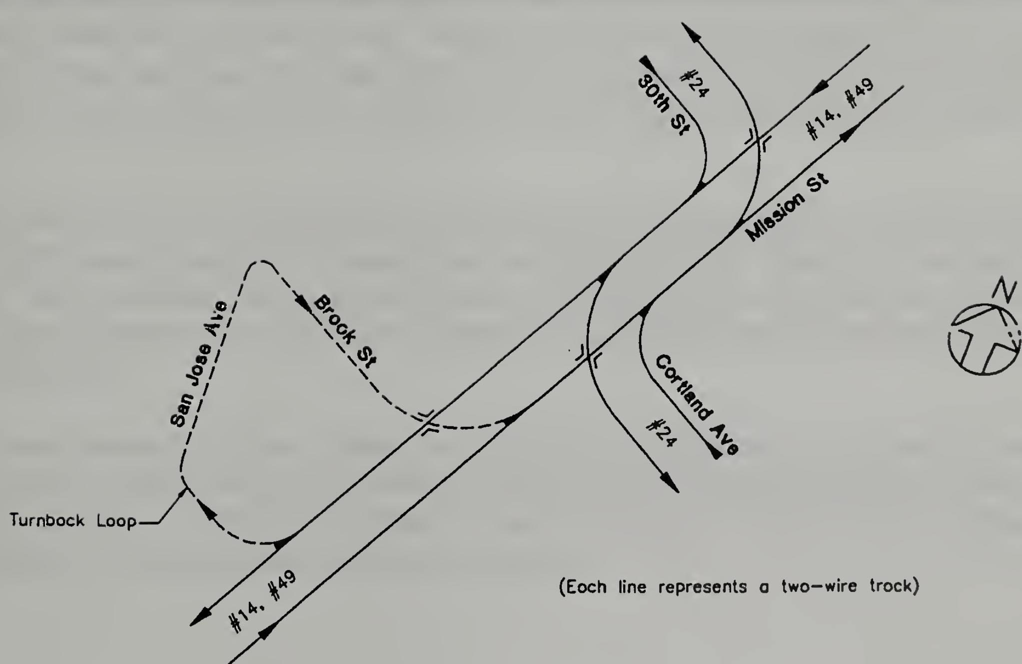
Of special note is the 14-Mission trolley bus, which provides local transit service generally above and parallel to the BART line along the entire Mission Street Corridor. The 26-Valencia also is a downtown route that generally parallels BART only one block to the west on Valencia Street. The nearby J-Church light rail line on San Jose Avenue and Church Street is an alternative downtown rail transit route, running very generally parallel to BART and entering the Market Street subway. The other bus lines are either crosstown or local routes. The 24-Divisadero trolley bus is a very important crosstown route. It extends from the Marina District in the north through the Castro District all the way to the Bayview District to the southeast. The 49-Van Ness trolley bus extends north to the Fort Mason area and south to City College.

The MUNI trolley bus wire layout along Mission Street is illustrated in Figure 4-B. The 14-Mission wire tracks run along the entire Mission Street segment. The 24-Divisadero wires enter/leave the Mission Street wires at the 30th Street intersection and leave/enter the Mission Street tracks at the Cortland Street intersection. Thus there are two major wire junctions, each consisting of two turnouts and a diamond crossing at these two intersections. In addition, there is a trolley bus turnback loop for the 14-Mission which diverges from the Mission Street wires southbound and traverses San Jose Avenue, to reenter Mission Street northbound via a left turn from Brook Street. The latter includes one turnout and one diamond crossing.



SF MUNI TRANSIT ROUTES
(See also Figure 1 for MUNI Route Extensions)

FIGURE 4-A



EXISTING MUNI TROLLEY BUS WIRES

FIGURE 4-B

FOR STUDY PURPOSES ONLY

30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

Existing Surface Traffic

The City of San Francisco Department of Parking and Traffic has conducted the “Bernal Heights Traffic Calming Study” from which excerpts with traffic and accident data are included in Appendix ‘B’. In summary, the total daily traffic volumes on Mission in the segment south of Cesar Chavez Street is 10,668 vehicles (counted on Monday, February 26, 2001). Traffic design is based on peak hour volumes:

- Morning Peak Hour Volume: 987 vehicles, Northbound
- Evening Peak Hour Volume: 702 vehicles, Northbound

The theoretical capacity of a free-flowing (freeway) traffic lane is 2,000 vehicles per hour. For a signalized urban arterial street, this is reduced to about 1,500 vehicles per hour through each point of conflict between crossing lanes at an intersection. This impact is, however, highly subject to modification due to signal timing and the allocation of signal ‘green time’ to the conflicting flows. Lane capacity can also be reduced by substandard width, adjacent parking, left-turns, driveways, pedestrians and heavy vehicles in the traffic flow.

Therefore the actual traffic capacity of the Mission Street lanes is reduced according to these factors. Also, the City of San Francisco has a deliberate policy to promote the movement of buses on transit-oriented streets. On Mission, bus stop sidewalks ‘bulbs’ have been constructed to facilitate bus loading, but this requires the buses to block the right traffic lane. The advantage to the buses is that unlike but ‘duck-outs’ which are more common in other cities, the sidewalk bulbs do not require that buses leave the traffic lane or wait to remerge into the traffic flow. This design policy is to the clear benefit of transit, but at the expense of the traffic capacity of the right lane.

The City Department of Traffic study states that excessive traffic volumes in residential areas are associated with queuing, aggressive driving and cut-through traffic. During the outreach efforts of the study, the community had expressed concerns about traffic levels on several streets within the study area. However, the results of the traffic survey actually demonstrated that volumes are comparatively light.

The study also showed that Mission Street had a relatively large number of pedestrian accidents, with the Cortland Avenue intersection having the highest rate. This accident trend illustrates that the highest numbers of accidents generally occur at locations with relatively higher traffic volumes together with significant pedestrian movements.

Existing Utilities

Utilities consist of the following types:

Overhead Utilities:

- MUNI electric trolley bus traction power overhead wire system

Underground Utilities:

- Combined drainage and sanitary sewer lines
- City water lines
- PG & E electric power lines
- Telephone and TV cable conduits
- PG & E gas lines
- City traffic signal and street light electric conduits
- MUNI electric trolley bus traction power feed cables

The MUNI trolley bus overhead system consists of a pair of trolley contract wires (two wires per 'track') in each direction, charged with 600 volts DC. These are supported at about 100-foot intervals by cross span wires which are in turn attached to street lighting poles ('joint' poles) along the sides of the street. This is a simple 'fixed termination' type trolley system without counterweights or complex tensioning devices.

Additional information on existing utilities is included in Appendix 'C'.

For the purposes of this study, utility relocation issues are relatively minor and will not be a deciding factor in evaluation of alternatives. They are also a comparatively minor cost factor.

Soil Conditions

The existing underground soil conditions in the vicinity of the proposed project are very well documented due to the original BART tunneling. The more alluvial soils tend toward the north of the segment along Mission, with rock encountered in the south near Glen Park Station. Appendix 'D' includes sample soils information.

3. APPLICABLE PROJECT GUIDELINES & DESIGN CRITERIA

As most transportation agencies, BART has codified its most important engineering standards for design of its facilities. These formal criteria include those that establish dimensions and numerical indices for its physical plant. In addition, there are operational factors that limit how a particular facility may be configured, so as to adequately serve its intended function. The BART staff had developed an original station criteria list, which is included in Appendix 'E'. The most important of these as they relate to a possible 30th Street Station are described below:

BART Design Configuration Criteria

- *Design Speed:* This is the highest train speed that the trackway and facilities must accommodate. The present design speed for this segment is set by the radii and superelevation of the existing nearby horizontal curves, and is 80 mph. It would be preferred to design the new station and its track approaches so that this speed not be diminished. However, since trains stopping at the new station would have to slow down, a lower train speed might be acceptable approaching the station from either direction. Such a lower speed has been provisionally set at about 36 mph for the track approaches near the station platforms.

- *Track Gradient:* The desirable gradient along station platforms is zero (flat grade), and most existing BART stations are so configured. The maximum gradient for the track at platforms is 1.0 per cent. This gradient at stations is limited by major hardware and software constraints built into the BART vehicle and control systems. **This is a very important criterion, and it is a defining standard for this project.** (However, even if the 1.0 per cent criteria could be relaxed, the platform gradient limit of 1.5 per cent would then govern the track as well, as described below.) For other track segments on the most demanding grades approaching the new station, a 4.5 per cent maximum grade limitation is proposed for short distances.

- *Platform Gradient:* This is limited by the Americans with Disabilities Act (ADA). The ADA criteria require that the platform be nominally level. ADA defines level as a maximum gradient of 1:50 (2.0 per cent) on a constant plane in any direction. However, to allow for platform drainage, the platform should also have a cross-slope and 1.5 per cent is the standard used. The resulting maximum allowable combined longitudinal/traverse slope is then 1.322 per cent. The 1.5 per cent platform cross slope is also a BART standard. Also, all vertical circulation elements (i.e. stairways, elevators, and escalators) need to be founded on a platform with a gradient which does not exceed 1.5 per cent. Therefore, taken together with the track grade criteria, a maximum longitudinal grade of 1.5 per cent is confirmed for the station platforms.

- *Platform Length:* Shall be adequate for a ten-car train, about 700 feet.

- *Vertical Curvature of Tracks:* The BART Standards do not permit vertical curvature (changes in grade) along station platforms. However, again for the purposes of this study, and due to the constraints of the site, a relaxation of the standards is suggested, subject to further study. Thus for any alternative with vertical curves at platforms which

are not on the main line tracks ('off-line' platforms), these may encroach into platform areas beyond a central 'touch down zone' reserved for the vertical circulation elements. This enroachment zone should not exceed 150 feet from the ends of the platforms.

- *Track Turnouts (switches):* Turnouts to off-line station platforms and/or pocket tracks shall be #15 right hand and left hand, and #10 equilateral. This corresponds to a design speed of 36 MPH.

Exceptions and Deviations from Design Criteria

The above are the most important numerical design criteria. In those cases as described above, the suggested project criteria are somewhat less conservative than the regular BART standards presently allow. The reason for this is that the constraints of the site are severe, and if the BART criteria were strictly enforced, either no alternative would be feasible or a compliant design would be extremely costly.

In such cases, the BART engineering department, as is the case with most other engineering agencies, may allow a digression from a particular established standard, subject to certain conditions. These would include limiting the magnitude of the digression and also assuring that the digression does not introduce a safety or operational or other functional problem. Obtaining such an exception to the rules would require a detailed engineering review, which is outside the scope of the present study. Therefore the results of this study, where they are based on use of some non-standard features, need to be considered provisional only, subject to further review, verification and approval.

Engineering Challenges:

- Existing track grade is greater than three per cent
- No decrease in system service levels permitted
- Provide both northbound and southbound service access
- Maintenance of service throughout construction
- Minimization of disruption to existing communities

Other BART Functional Criteria

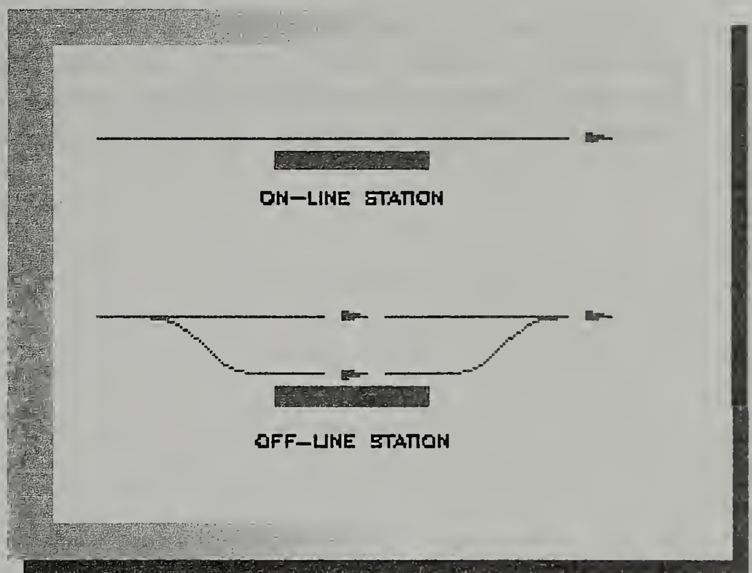
The following criteria relate to providing for certain needed functions of the proposed new facility: The first two criteria are obligatory, while the following criteria are either desirable or optional.

- *Obligatory – ADA Compliance:* Handicapped and elderly are to be provided convenient access to all public areas. All BART stations must meet the various published building codes, including adherence to ADA requirements for handicapped access.
- *Obligatory – Provide Station Mezzanine:* BART requires that passenger access to the track platform level be via a mezzanine/concourse level for fare collection and related functions.

- *Obligatory/Desirable – Maintain Line Capacity:* The new station should not significantly degrade the capacity of the BART line. This criterion should be considered *Obligatory* for at least one design alternative.

- *Desirable – Construction Impacts:* The construction of the new facility should not unduly hinder BART train operations during the course of the work. Although at least some disruption of service at limited times is unavoidable, various alternatives may have differing impacts on maintenance of train service.

- *Desirable – Provide Mainline Bypass Track:* With a bypass track, some trains may not have to stop at the station. Accordingly, these trains would have a shorter travel time and provide better service to those passengers who do not need to use the new station. However, this introduces potential operational problems and increases the wait time for those passengers that do wish to use the station. This issue introduces the concept of 'off-line' vs. 'on-line' platforms and is addressed further under each of the specific alternatives.



- *Optional – Revenue Train Turnback:* The opportunity afforded by construction of a station along the BART line provides the option of improving other BART functions as part of the project. A train turnback capability can be considered to permit reversal of revenue trains (trains carrying passengers), either to/from the north or south. This would permit easier adjustment of line capacity in different segments of the line, and could allow for improved overall passenger service. However, the additional cost of such an adjunct should be considered separately from the basic station cost because its incremental extra cost needs to be separately justified by its specific benefits.

  Any station with turnback function also would need to include train crew facilities, which are obligatory at such 'terminal zones'. These are breakroom facilities, restrooms, lunch area and the like.

- *Optional – Disabled Train Storage:* A pocket track might be added for side-tracking of malfunctioning trains. This is also an extra cost item.

Non-BART Standards

These would apply to surface street and utility reconstruction made necessary by excavation for the new station.

Surface street standards would be those by the City of San Francisco Department of Public Works, as for lane widths, sidewalk and bike lanes, traffic signal, street lighting, sewer facilities and the like.

San Francisco MUNI standards would apply to reconstruction of the trolley bus overhead system and for bus stops. Other utility standards would be as required by the utility companies such as PG&E.

Where major street reconstruction is required, consideration might be give to reconstruction to higher, more modern standards. Such 'betterments' as widened traffic lanes, improved bus loading features, turn pockets, new bike lanes and landscaping might be considered if additional right-of-way becomes available. The requirements for these are outside the scope of the present study.

4. ALTERNATIVE DEVELOPMENT

Basic Design Approach

In order to comply with site constraints as well as applicable design criteria and operational standards, all potentially feasible alternatives need to be developed with a common philosophy and approach, and must have certain basic features in common. These include:

1. *Basic Station Configuration:* All alternatives involve underground subway stations. While other types of stations such as open cut types, might be theoretically possible, the limited surface area, track grade requirements and potential environmental impacts dictate that only a subway station is considered feasible. The new station also must provide separate platform and mezzanine levels. Due to the depth of the tracks, the mezzanine level would be above the track level and below the surface street level.

   Station platform length must be adequate for a 10-car train, about 700 feet, but the mezzanine level may be considerably shorter. The size of the mezzanine level would be subject to later detailed study but must be large enough to accommodate elevator/escalator access to/from the track level below and the street level above. It must provide sufficient space for the various mezzanine functions such as fare collection, attendant booth, BART systems enclosures, and security features. In general, a minimum size mezzanine would be least costly and most secure, while a larger mezzanine would provide more opportunity for street entrances and easier pedestrian access from different directions. Another factor which influences mezzanine length, is the requirement for this infill station to be constructed on no more than a 1.0 per cent grade. Despite this, the mezzanine level should be flat. This fact imposes another length constraint on the mezzanine.

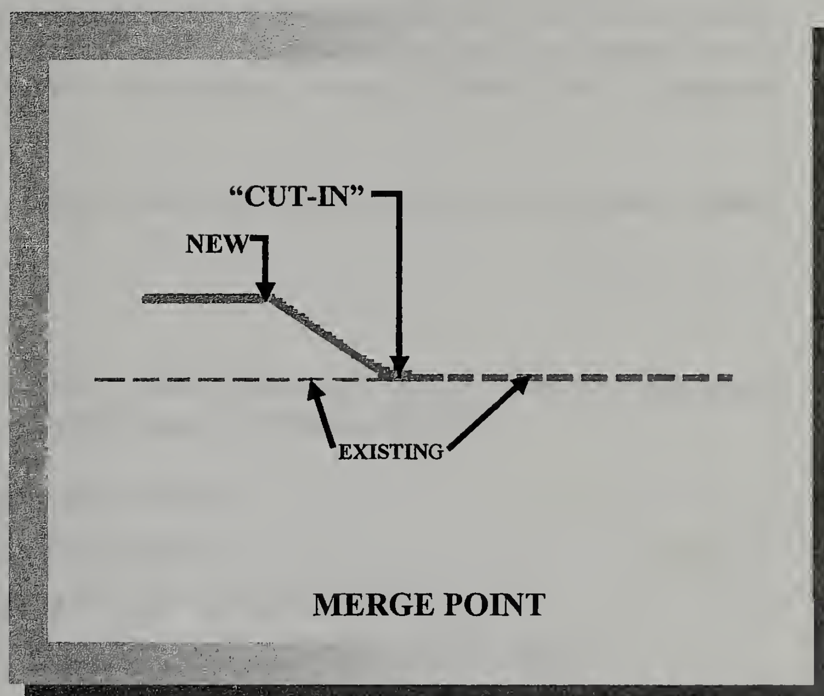
   Escalator, elevator and stair access from the street level down to the mezzanine are subject to considerable flexibility as to location. These need not always be located directly above the mezzanine or the main station box structure. Alternatively, they may be oriented in various directions, east-west for example, if such might yield more patron-friendly entry points. Sometimes the pedestrian entrances can be constructed more distant from the station box by excavating subsurface pedestrian corridors to more convenient entry locations. However, each corridor like this would add cost and construction disruption, and might be regarded as a potential security problem when complete.

2. *Station Grade:* **The requirement to revise the track grade at the platforms from the existing 3.1 percent to a flatter 1.0 per cent obligates the design to include extensive reconstruction, including long approach tunnels, to provide the needed transition.** This involves a profile with several new vertical curves, and results in a construction segment considerably longer and more costly than would have been the case if the grade-reduction problem did not exist.

3. *'Off-Line' Construction:* Because BART train service must be maintained during construction, and also because the new tracks must be constructed on a different profile grade

than the existing, the new tracks and platforms and the tunnels that contain them must be constructed separate from, and away from the existing tunnels.

4. *Merge of New Work into the Existing Tunnels:* At the extreme ends of the new tunnels and trackage these have to be connected into the existing tunnels and tracks. When complete, the new work must be switched over to or 'cut-in' at the limits of the new construction. There are two such locations along each track direction, totaling four 'cut-in' merge points. Each of these would resemble a branch in the tunnel configuration.



This aspect of the project is highly problematic as it involves potential interruption of train traffic while the work proceeds. The underground location of all the construction also entails extreme difficulty because work area is limited and access is very awkward. Much of the construction work at the four merge locations would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended. Thus regular BART service would have to be cut back during evening and weekend periods with resort to single-track operations, possibly augmented with extra bus service. (See following Sections on Construction Impacts and on Operations.)

5. *Operational Considerations:* The introduction of a new additional station on the line would result in an increase of travel times for all trains that stop at the station. The implications of this are that travel time for system users would be increased, and that the number of trains (i.e. the amount of rolling stock) might be subject to an increase in order to support the existing service. These issues are addressed more fully in the following Sections of this report on operations and capacity.

   Due to the 'off-line' nature of the construction, as described above, there is an option to retain the existing tunnel in service for a bypass or 'express' track so that some trains could travel past the station without net increase in their travel time. However, this would reduce utility of the new station, as the wait for a train would be longer than at other stations.

   Other operational options involve the possibility of a turnback of some trains. This would require a more complex track and tunnel configuration. The potential benefit would be to

facilitate adjustments in line capacity and service in various segments of the BART system. This feature does not now exist along this line segment, and it may become more important with extension of the BART system to the south. The improved ability to turn back trains could reduce the schedule demand on the very costly BART fleet of rolling stock.

For example, certain trains arriving from downtown might be turned back at 30th Street Station if it is determined that train capacity is underutilized to the south. Or alternatively, trains from the south might be turned back at 30th Street toward Millbrae/SFO if it is determined that the line toward the Eastbay cannot accommodate them all. The presence of a turnback can also facilitate the use of shorter trains on more frequent headways if this is deemed beneficial for certain segments. (The addition of new crossover tracks elsewhere on the BART system is currently under consideration because of these same operational benefits.)

A turnback and tail track could also be used to remove disabled trains from service and so reduce service interruptions.

Alternatives Considered

Following a 1998 'Sketch Study' by BART, a total of seven alternatives were later developed and considered. Initially, the present study had included the following six:

1. Double Pocket Turnback Station with Crossovers
2. Single Pocket Turnback Station with Crossovers
3. Single Pocket Station with Stub-end Storage Track and Crossover
4. Two-way Single Center Pocket Turnback Station with Third Level Platform
5. Stacked Back-to-back Center Pocket Turnback Station
6. Double Pocket Turnback Station

In addition, an on-line alternative using the existing tunnels and tracks was also previously suggested. It was illustrated in a brief May 1988 submittal prepared by BART staff and Bay Area Transit Consultants (BATC), and is illustrated in Appendix 'F'. This concept is now considered infeasible because of the need to revise the track gradient and for other reasons described above.

History and Selection of Alternatives

- 1998 Sketch Study by BART
- Established minimum design criteria
- Developed approximately ten alternatives
- Initial alternative screening
- Identified engineering & operational challenges

At an October 2001 meeting, BART staff reviewed progress on the above six alternatives and concluded that the first and sixth alternatives merited further study and refinement. The other four alternatives are considered to have little overall merit and

include some features that are very unattractive, especially from the operational standpoint, thus constituting 'fatal flaws'. Therefore these alternatives have been dropped from further analysis, but are described in Appendix 'G' as "Other Alternatives Considered".

The two most promising alternatives were chosen by BART staff so as to best represent two fundamental objectives. The sixth alternative entails a basically feasible lowest cost station option. It has been redesignated, **Alternative 'A' – On-Line Station with Optional Turnback** and is further described below. Certain modifications to the initial rendition of this alternative have been made in order to further reduce its cost. For example, the turnback function has been removed from the basic scheme, although the turnback may still be considered as an extra cost option.

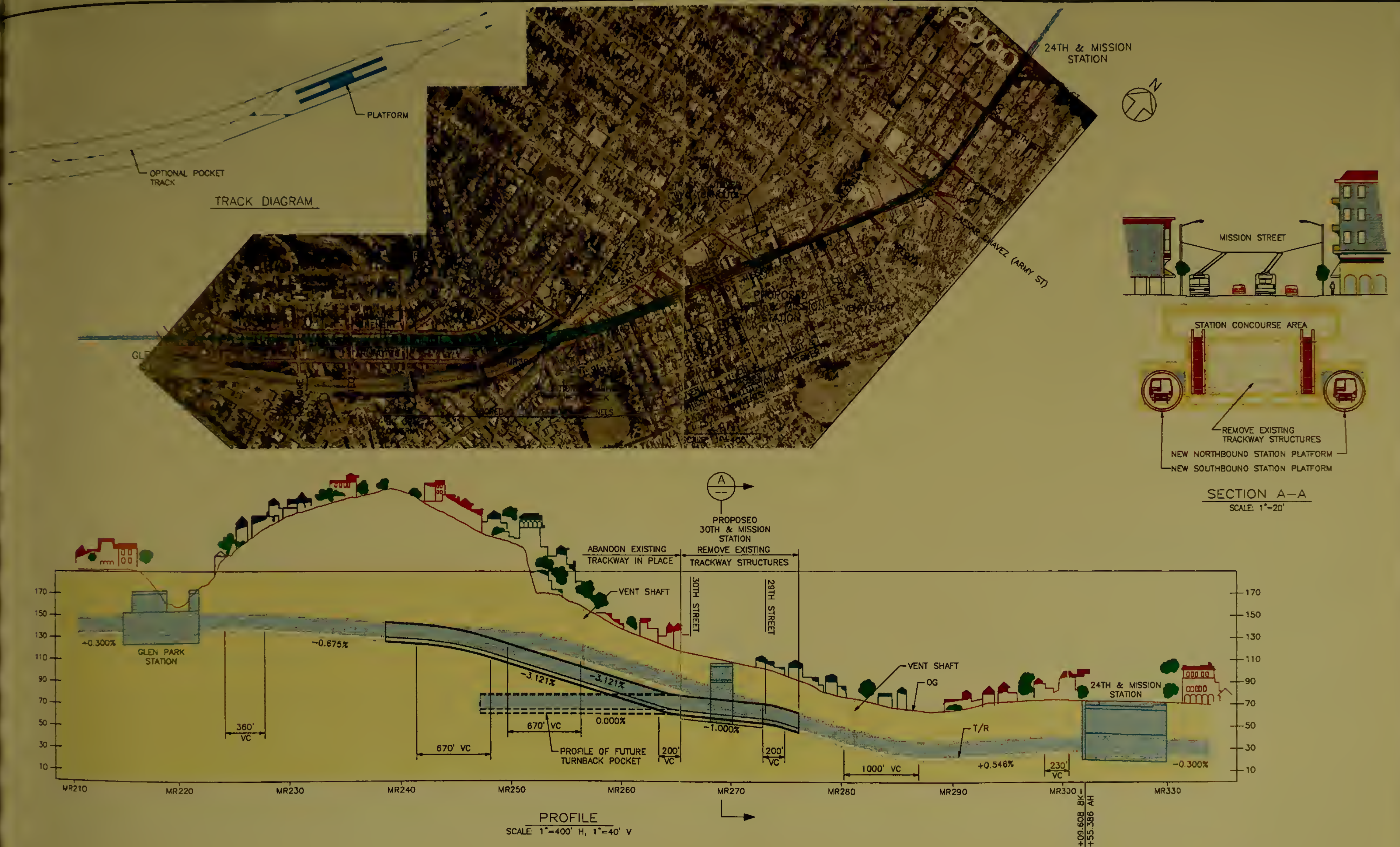
The first original alternative involves a higher-cost station configuration that is considered fully adequate to support optimum operations of the BART system. The operations benchmark used for the basis of this design is that level of service anticipated as a result of all current BART systemwide programs of improvement. This scheme has been redesignated **Alternative 'B' – Off-Line Station with Full Turnback**, and is further described below. Again, certain modifications to the original rendition of this alternative have been made, in this case also to reduce its cost.

***Alternative 'A' Description: On-Line Station with Optional Turnback** (Low Cost Alternative)*

This concept, as shown in Figure 5, involves construction of the new northbound and southbound station platforms and tracks on the outside flanks of the existing BART tunnels. The positions of the new tunnels are defined by the closest distance to the existing tunnels that would facilitate safe construction. The new station is planned on a 1.0 per cent grade and thus new approach tunnels are required to conform back to the existing tunnels on both the north and south ends. The profile as shown dictates that the approach tunnels to/from the south be considerably longer, at about 2,500 feet, than those to/from the north. The approach tunnel grade of 3.12 per cent was selected to duplicate the existing grade of the BART line at this location.

The intent of this scheme is to completely replace the existing tunnels at this location, and the existing tunnel segments at the platform location would be demolished and removed. Other abandoned segments of the existing tunnels would be left in place and might be used to accommodate BART systems facilities or utilities or storage.

In this scheme, the two BART tracks would be relocated to the new station and tunnels and there would be no other tracks provided. Accordingly, the merge locations into the exiting tunnels would need to accommodate track geometry adequate for the highest speed train anticipated to travel through these locations. This design speed would need to provide for any trains that might not actually stop at the station including out-of-service trains or any skip-stop trains anticipated in future operating plans. For this reason, geometry of the tunnel merges would be longer for the track curvature needed for this scheme.



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ALTERNATIVE A

ON-LINE STATION WITH MODIFIED PROFILE AND FUTURE TURNBACK POCKET TRACK

BASIC CONCEPT

FIGURE 5

30TH & MISSION BART INFILL STATION STUDY

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The station platform anticipated by this scheme is very generous in width because it must extend across the area previously occupied by the pre-existing tunnels. Nevertheless, the overall station footprint is conservative with respect to right-of-way width. The mezzanine/pedestrian concourse length is shown as a minimum length (much shorter than that at the adjacent 24th Street Station) option in order to save cost and minimize construction impact.

The center platform would have the configuration of an 'H' with the central area beneath the mezzanine, about 300 feet long and extending fully across between the two tracks. The balance of the 700-foot long platforms would be in the form of single platforms (the 'legs' of the 'H') along each track with each extending about 200 feet outward in both directions from the central area. This configuration would permit the four narrower segments of the platforms to be constructed within mined tunnels, so that the size of the cut-and-cover excavation pit could be minimized. The potential to retain existing buildings undisturbed on the surface could thus be improved. (See following Section on Right-of-Way Issues.)

The basic scheme requires no track turnouts or junctions, however, there is an additional option to provide a turnback pocket track (illustrated in dashed lines) to the south of the new station in the space between the two new main line tunnels. This would entail the provision of three track turnouts in the shape of a 'wishbone' as shown. The purpose of the turnback would be to permit reversal of some revenue trains from the north and/or as a location to remove disabled trains from the main line. The turnback tunnel, as illustrated, is preferred to be on a flat grade. It should be about 1,500 feet long, to accommodate two full 10-car trains.

Due to the additional cost of the turnback track, its benefits need to be balanced against its costs as if it was a separate project.

Station Function - Alternative 'A'

Train movements through the station would be similar to those at other existing BART stations. These consist of deceleration of the train into the station, station dwell, and acceleration out of the station in the same direction. The optional turnback track could be used in one of two basic ways:

1. If used for revenue train turnback, a southbound train would enter the station from the north and stop to discharge all passengers. It would then proceed onto the turnback track and stop there. The train operator would then move to the opposite end of train ('change ends') and prepare for departure. Departure of the train to the north would be only at a time when BART Central Control had identified an adequate schedule 'gap' between the northbound trains approaching from the south, so as to accommodate safe entry of the turnback train onto the main line. The train so accommodated would proceed into the station and stop to board passengers for subsequent departure to the north. The turnback track as illustrated has no direct connection to the south and thus could not accommodate revenue train turnback from that direction.

2. The second type of usage would be to store a disabled train. For a disabled train arriving from the north, entry into the pocket track would be similar to a revenue service train from that direction. But a disabled train arriving from the south would have to stop at the station and then proceed into the pocket track by means of a reverse maneuver. This would entail changing ends at the platform and would require more time, while blocking the main line. The disadvantage of this needs to be balanced against the probability that such a maneuver would be very common. A further unillustrated option would be to add additional track access from the south. This would add greatly to cost and require a revision away from the preferred flat grade for the turnback.

Alternative 'A' Advantages

- Simplest track configuration and train operations
- All trains would stop at the new station
- A narrower mezzanine is needed than for Alternative 'B', thus minimizing property impacts
- The single, wide center station platform is a passenger amenity
- The scheme does not include crossover tracks, which would be disruptive to train service to construct
- An optional turnback track is possible at extra cost
- The basic scheme has marginally lower construction cost than Alternative 'B'

Alternative 'A' Disadvantages

- The new station stop would reduce BART main line capacity
- New track curves may impose additional train speed restrictions
- Less operational flexibility than Alternative 'B' which permits train bypass of the station
- The optional turnback track is costly and is not easily accessible from the south
- The station platform level would need to be constructed in two stages (see section on Construction Impacts)

Alternative 'B' Description - Off-Line Station with Full Turnback ***(Optimum BART Operations)***

This scheme, shown in Figure 6, provides for new station platforms and tracks in addition to retaining the existing tracks and tunnels as a main line bypass. This alternative also provides an operational option for turnback capability and/or disabled storage train.

Similar to Alternative 'A', Alternative 'B' also involves the construction of two new station platforms and tunnels to the outside flanks of the existing tunnels. Also similar to Alternative 'A' a new flattened track grade of 1.0 per cent is provided, and approach tunnels are needed in a similar configuration. Unlike Alternative 'A', this alternative utilizes turnouts at all the merge locations so that trains approaching the station may either proceed to a stop at the platforms or bypass the station using the pre-existing tunnels and tracks.

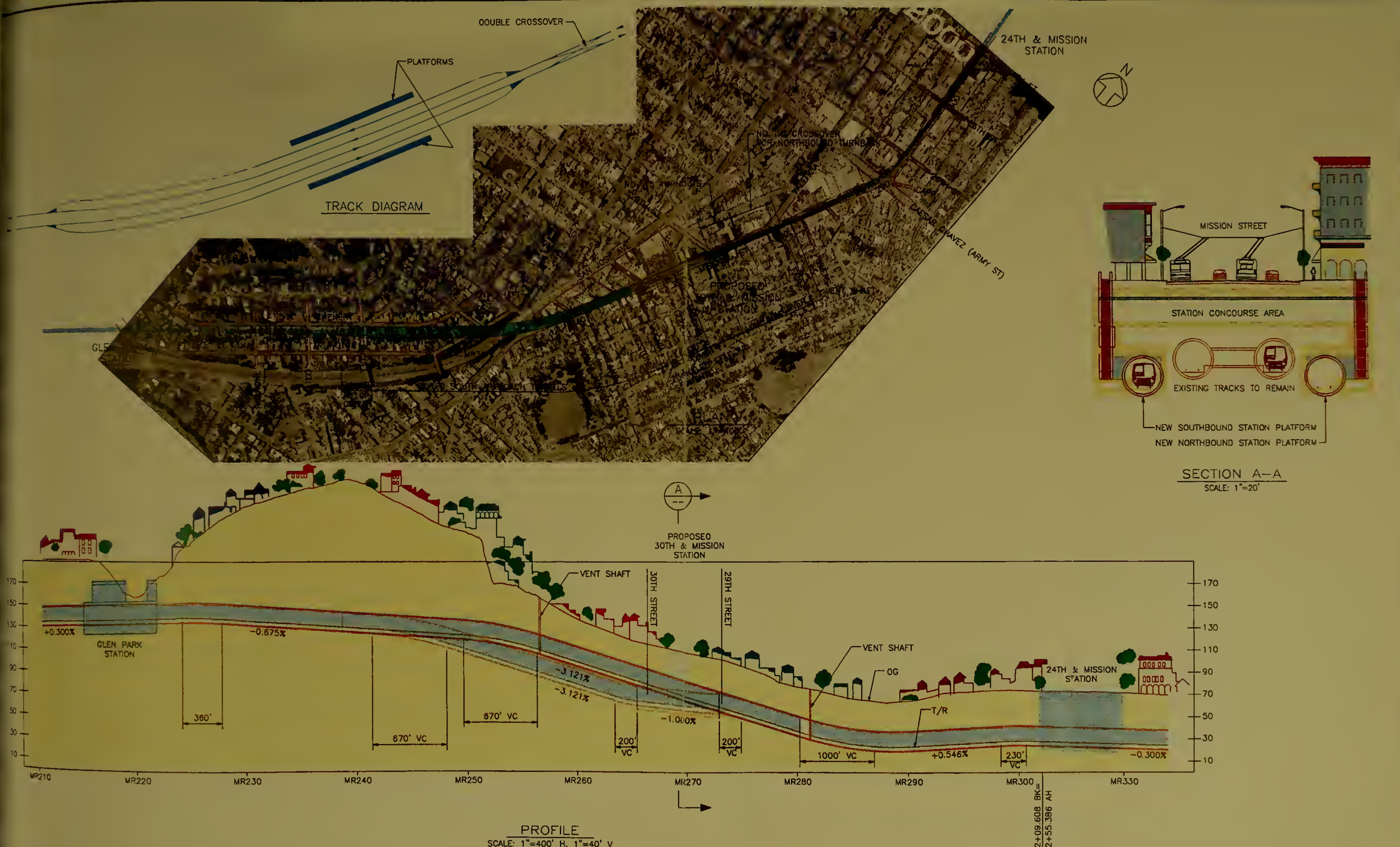
Because only those trains stopping at the station would need to diverge (at about 36 mph) from the higher speed alignment, it is possible that the merge locations might be constructed in a more limited space. This could save construction time and reduce interference with train operations during 'cut-in'. However, these merge junctions would need to accommodate more complex trackwork and signaling features related to the turnouts.

Station Function - Alternative 'B'

This scheme could accommodate express trains that would bypass the station. This type of operation would improve speed and runtime of some trains and thus support higher line capacity. On the other hand, if there were too many express trains, service to the new station would be diminished. Furthermore, this limited project would not be sufficient to result in substantial development of express train service because the bypass track would not extend beyond this single station.

For trains stopping at the station, operations would entail the usual deceleration and stop, either northbound or southbound. But departure from the station would be more complex if the main line bypass track was being used. In that case, the stopped train would have to await a 'gap' in the schedules of the bypass trains, and that might result in an elongated dwell time and increased delay for passengers on the stopped trains that serve the station. (See following Section on Operations).

The scheme includes a main line double crossover track just north of the station. This occupies more space than does Alternative 'A'. The location of the crossover is such that the existing vent shaft to the immediate north should remain undisturbed. The double crossover could serve as a revenue turnback for Transbay trains to/from the north but not to/from the south. However, the use of the center tracks for either turnback or storage conflicts with their possible function as bypass tracks. These different functions cannot occur at the same time, although the tracks could serve different functions at different time periods.



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ALTERNATIVE B
OFF-LINE SIDE PLATFORM STATION WITH NORTHBOUND TURNBACK CAPABILITY

FIGURE 6
30TH & MISSION BART INFILL STATION STUDY
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Alternative 'B' Advantages

- Provides bypass tunnels facilitating express train operations
- Compared to Alternative 'A', minimizes capacity reduction in BART system
- No new restrictions on express train speed
- More flexibility in turnback operations (to/from north and south)
- The station platform construction could be completed in one stage (see section on Construction.)

Alternative "B" Disadvantages

- Greater operational complexity
- Potential for delay of trains reentering main line from the platform tracks
- All trains may not provide service to the station
- Express train turnback operations and disabled train storage are mutually exclusive uses of the second pair of tracks
- The turnback capability is available only to/from the north
- More complex trackwork, especially the crossovers, may increase service interruptions during construction
- Slightly more right-of-way needed than for the basic Alternative 'A'
- Separate narrow platforms are less attractive for passenger use than a center platform, and need additional escalators and elevators resulting in higher operating costs
- The separate platforms might also be more confusing to use for passengers boarding or transferring to/from turnback trains. This is because the transfer might entail level changes via the mezzanine which would be needed to get from one platform to the other
- Slightly higher construction cost than Alternative 'A'

'Things to Consider' for BART Operations

The following table is derived from the listing of BART staff concerns circulated during the initial study discussion phase. It is a list of things to consider when analyzing the advantages and disadvantages of the 30th Street infill station:

'THINGS TO CONSIDER'	*Basic Alt 'A'*	*Alt 'A' w/Pocket Track*	*Alt 'B'*
SERVICE			
– *Will the station provide staging for events and special service, pocket tracks, additional thru tracks, etc?*	*No*	*Minimum*	*Maximum*
– *Will the station impact existing service? (Increase in runtime may require additional consists and slow travel times)*	*Yes*	*Yes*	*Sometimes**
– *Will the station impact proposed AATC service increases?*	*Yes*	*Yes*	*Sometimes**
– *Will the station enhance service optimization? (Can it be used as a turnback station for one or more lines thereby saving cars?)*	*No*	*Yes*	*Sometimes**
DELAY MANAGEMENT			
– *Will the station allow for truncation of service or act as turnback station?*	*No*	*Yes*	*Yes*
– *Will the station provide for bad order storage?*	*No*	*Yes*	*Sometimes**
– *Can 'swapping' of trains be improved to maintain schedule? (trains timed to turnback in correct scheduled slot)*	*No*	*Yes*	*Sometimes**
– *Will the location of the station improve chances for single tracking during 12, 15, or 20-minute service?*	*No*	*No*	*Yes*
SERVICE DESIGN IMPACT			
– *Will runtimes and dwells change the sequencing of service or layover times?*	*No*	*No*	*Yes*
– *Will headways limit storage?*	*N/A*	*No*	*Sometimes**
– *Will headway limit turnbacks and sequencing?*	*N/A*	*Yes*	*Sometimes**
CONSTRUCTION IMPACT			
– *Will construction have impact on mainline operations?*	*Yes*	*Yes*	*Yes*
– *Will cut-over be minimally invasive with little impact on mainline operations? (one or two weekends for cut-over)*	*Less*	*Less*	*More*
– *Will road manual operation, restricted speeds, single-tracking be used minimally?*	*Less*	*Less*	*More*
– *Will a bus-bridge be feasible, available, affordable?*	*No*	*No*	*No*

* *'Sometimes' indicates that the operational impacts will depend on exactly how the two additional tracks are utilized. The use of the center tracks for either turnback or storage conflicts with their possible function as bypass tracks. These different functions cannot occur at the same time, although the tracks could serve different functions at different time periods.*

5. RIGHT-OF-WAY ISSUES

As described earlier, in order to maintain BART train service during construction, and also because the new tracks must be constructed on a different profile grade than the existing, the new tracks and platforms and the tunnels that contain them must be constructed separate from, and away from the existing tunnels. The magnitude of the lateral (sideways) shift must be sufficient to provide protection of the existing tunnels from potential construction damage caused by the work. A separation of one tunnel-diameter is considered desirable to assure this. Special construction techniques as described later can be utilized to minimize, but not eliminate the tunnel space requirements, right-of-way takes, and surface property impacts.

The station itself, consisting of the mezzanine and most of the platform area, is too large to be tunneled or excavated out exclusively from below. Instead, open pit excavations would be needed for most of the station box construction. These pit areas, which would be temporarily decked over, also provide ingress for construction equipment and materials and egress for removal of excavated earth material. This method is almost universal for subway construction and was used for all the other BART subway stations. (Stations completely constructed in mined tunnels do exist, but they are relatively rare. They are very difficult and costly to construct except where very favorable rock conditions exist, and are used only due to extreme depth or other special conditions.) However, this study does consider construction of a portion of the station by tunneling, in order to minimize the size of the open excavation pits.

Right-of-Way

As illustrated, the 'footprint' of the station and its tunnel approaches extend beyond the right-of-way lines on both the east and west sides of Mission Street. Because much of the property frontage on the west side of the street is occupied by a Safeway parking lot, the station layout should favor right-of-way takes along the west side. The Safeway lot could then be rebuilt after project completion. However, some buildings on both the east and west sides would be demolished.

Some tunnel segments of the work, due to their depth, might be completed beneath existing buildings without disturbing them. Also, configuration of the mezzanine walls might be designed to skirt as many buildings as possible. However, the scheme does require a greater width than the available right-of-way, and some new right-of-way and building acquisition could not be avoided.

Land Use Considerations:

- BART promotes station planning where higher number of riders will justify investment
- BART recognizes that its San Francisco stations are amongst the highest generators of its ridership
- A Transit Oriented Development program would boost ridership and could make use of vacated right-of-way parcels
- Underground station construction in high-density areas has ridership benefits, but results in major right-of-way impacts

Areas of Open Excavation: Figures 5 and 6 illustrate the approximate limits of the areas that would have to be constructed from the surface by open 'cut-and-cover' means and also those segments that might be tunneled from below. Figures 7-A, 7-B, 7-C and 7-D show the approximate outlines of the surface excavations.

Three or four excavation pits would be required. The main pit, shown in Figure 7-A, would be excavated at the location of the station mezzanine, and its 'footprint' would generally correspond to the mezzanine perimeter measuring about 300 feet long by 200 feet wide. It would be located at the vicinity of Virgina Avenue and Godeus Street, and envelope the east side of the Safeway parking lot.

The outlines of the excavation pits as shown are necessarily diagrammatic at this stage. In general, the attempt is made to minimize the number of buildings taken. However, for the main pit shown in Figure 7-A, it has been assumed that a slightly more generous size excavation would be needed to accommodate the mezzanine level. This leads to the possibility of taking the row of buildings on the east side of Mission Street. Because these buildings would likely need to be taken, the excavation there is illustrated extending all the way back to the east property line. It follows that if these buildings are taken at all, it would therefore seem most desirable to utilize the entire property width, to be made available to enlarge the station mezzanine to the east.

However, the exact requirement for the mezzanine remain to be determined at a later design stage. It is quite possible that one or more of these buildings might be saved by refinement of the design. A more detailed design effort would not only address the mezzanine and building-take requirements of the tunnel alignments as now shown, but also consider the possibility of minor shifts in the tunnel positions themselves so as to further minimize property takes.

A second excavation, shown in Figure 7-B, would be located between 29th Street and Valencia Street, to the north of the main pit. This excavation would enable cut-and-cover construction of the subway structures that would accommodate the north track merge connections (and the crossovers of Alternative 'B'). This excavation, about 75-100 feet wide, and 200 feet long. (500 feet long for Alternative 'B'), might be narrower than the main pit because these is no mezzanine here. The west-side buildings are therefore shown as being saved. However, as indicated above, detailed design study is needed to verify the exact need for building takes. It is possible that some or all of the west-side buildings might actually need to be acquired.

The third excavation would be needed only for the Alternative 'A' option that includes the pocket track. This pit would enable the construction of the structure that would accommodate the 'wishbone' track connections. As shown in Figure 7-C, it would be located just south of the station about 250 feet south of the main pit. It would measure about 75 feet wide by 250 feet long.

The fourth excavation pit would be much further to the south, in the south quadrant of the Chenery Street/Miguel Street intersection as shown in Figure 7-D. This site would provide for construction of the south tunnel-merge structures. Due to the extreme depth here of over 100 feet, this would be a difficult excavation, and there is the alternative possibility of constructing a

cavern excavated mostly from below. The feasibility of this could be determined only after soil borings and detailed geotechnical analysis were undertaken. Even with excavated caverns, one or more small-diameter shaft(s) would be needed, drilled from above for soil stabilization, insertion of equipment and muck removal. Such shafts would also be essential if a tunnel boring machine is to be used. The outline indicated in Figure 7-D is that of the largest size pit that would be expected at this location, about 100 feet by 200 feet.

The other station segments might be tunneled from below in order to save property impacts and buildings. The station segment of 250 feet between the main pit and the north pit could be tunneled from below using manual mining techniques and perhaps 'microtunnels' to form their roofs. Its two large-diameter tunnels would each accommodate one track and the adjacent platform. This can be seen in the cross-section in Figure 7-E for Alternative 'A' and in Figure 7-F for Alternative 'B'. A similar station segment could be tunneled south of the main pit, leading to the south approach tunnels (or to the 'wishbone' pit for the Alternative 'A' pocket track option).

Property Acquisition: The approximate number of properties likely to be taken or occupied at each location is as follows:

Excavation	**Alternative 'A'** Basic	**Alternative 'A'** with Pocket Track	**Alternative 'B'**
Main Pit	6	6	6
North Pit	11	11	19
South Pit	6	6	6
'Wishbone' Pit	--	9	--
Total Number of Properties Taken	23	32	31
Total Private Property Area Taken	76,000 sq. ft.	98,000 sq. ft.	104,000 sq. ft.

The north pit excavation is oriented to minimize property takes on the west side of Mission; however for Alternative 'B', it does require the largest number of properties and these are mostly on the east side. In addition, there would be numerous buildings along Mission Street and properties above the south approach tunnels that would not be physically disturbed, but would be tunneled beneath within a subsurface right-of-way easement.

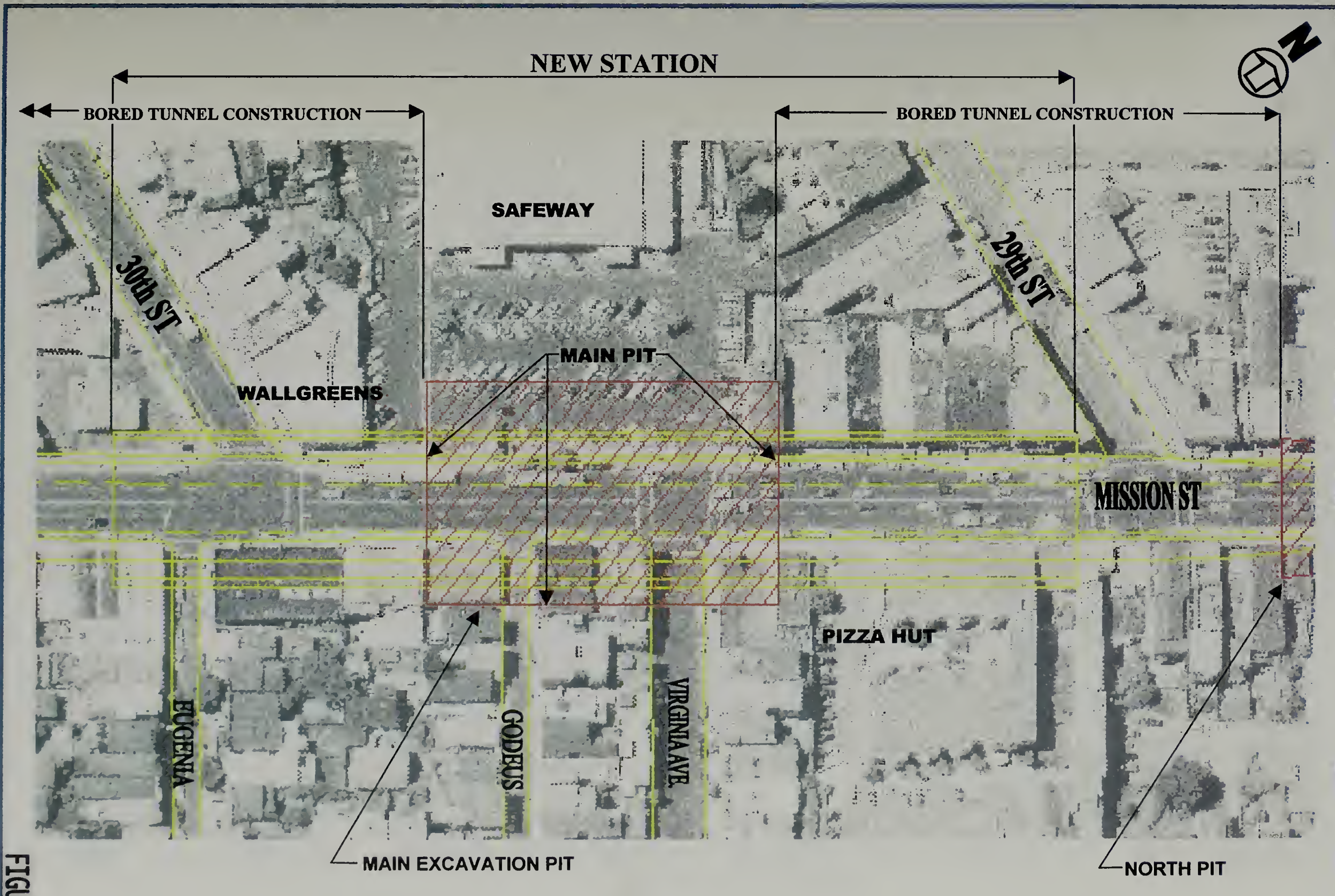

FIGURE 7-A
30TH & MISSION BART INFILL STATION STUDY
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FIGURE 7-A

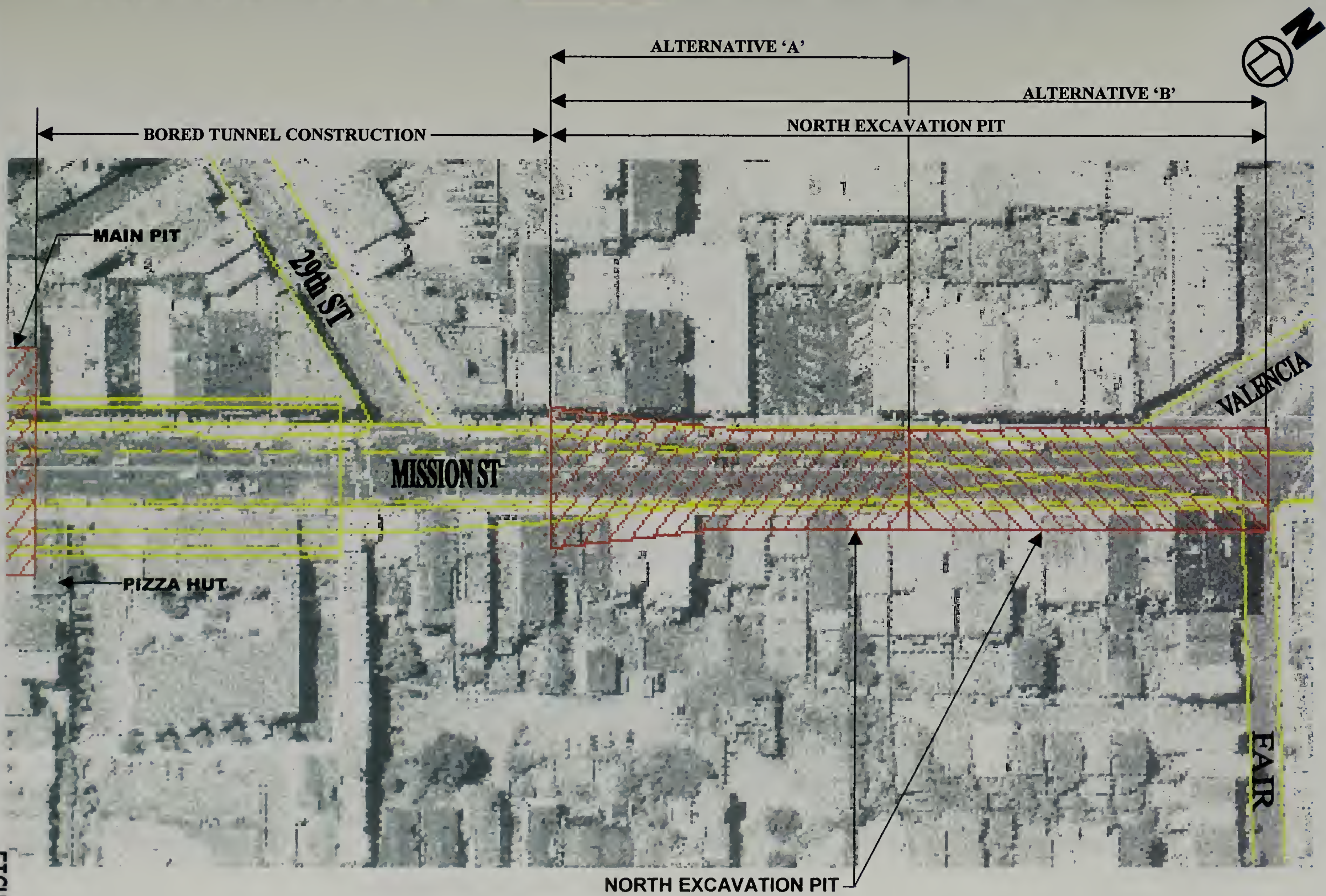

FIGURE 7- B
30^{TH} & MISSION BART INFILL STATION STUDY
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FIGURE 7-B

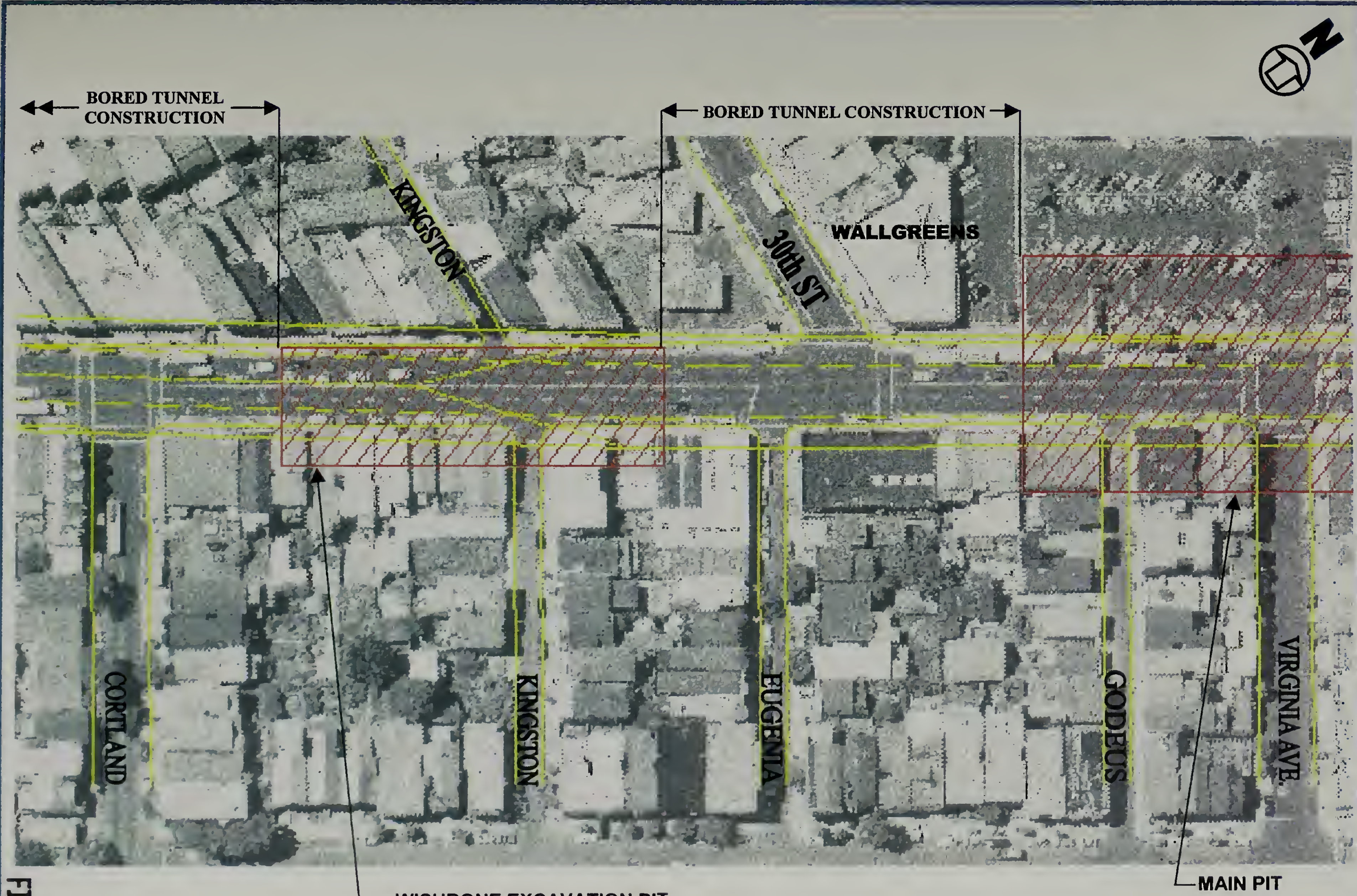

FIGURE 7- C
30^{TH} & MISSION BART INFILL STATION STUDY
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FIGURE 7-C

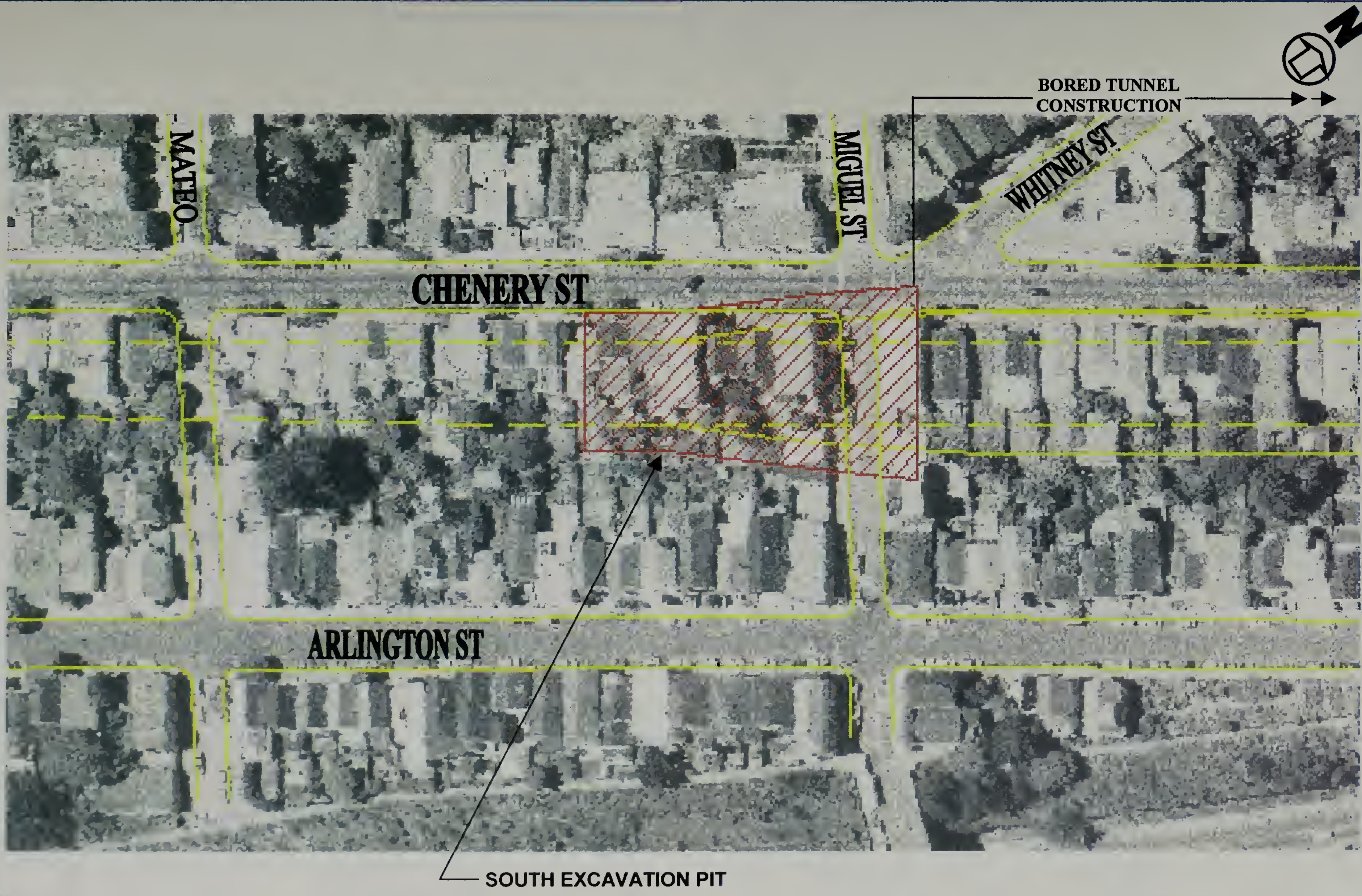

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FIGURE 7- D
30TH & MISSION BART INFILL STATION STUDY
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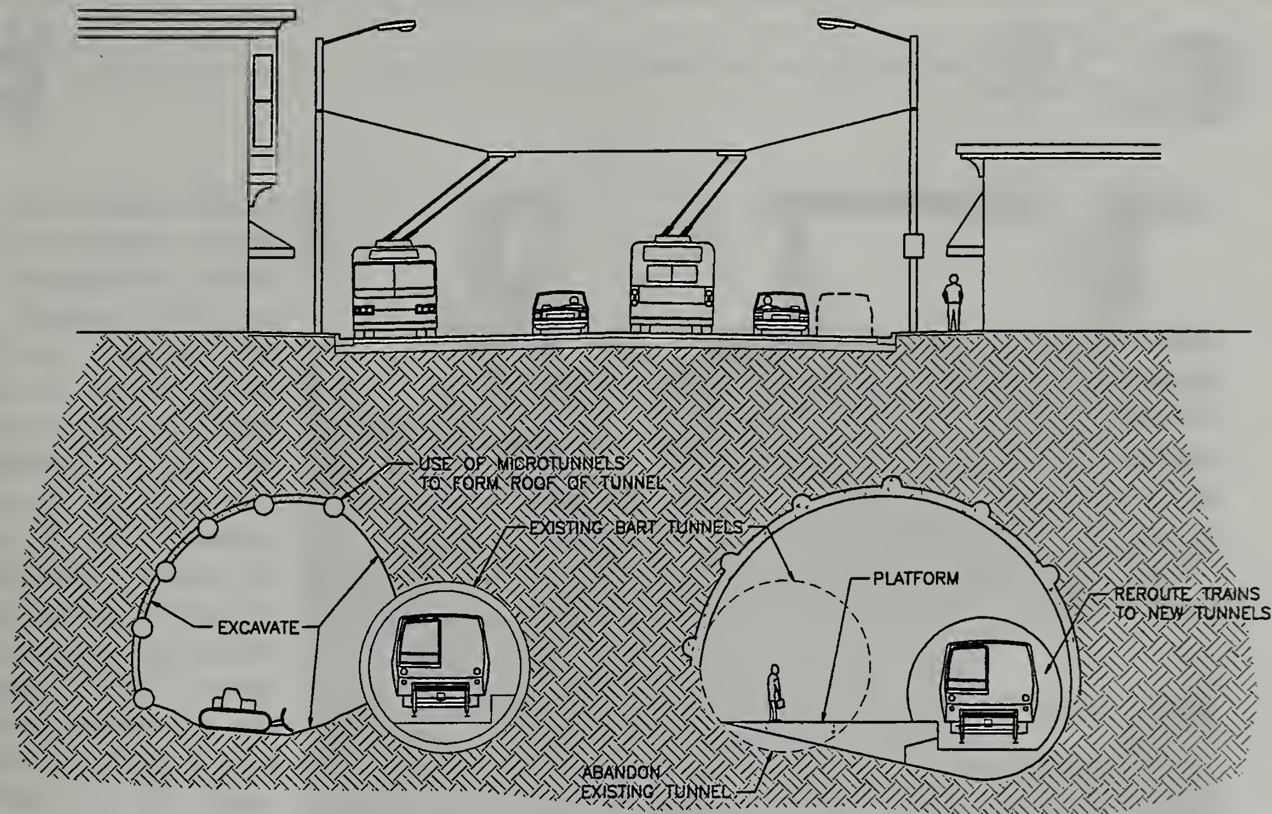
FIGURE 7-D

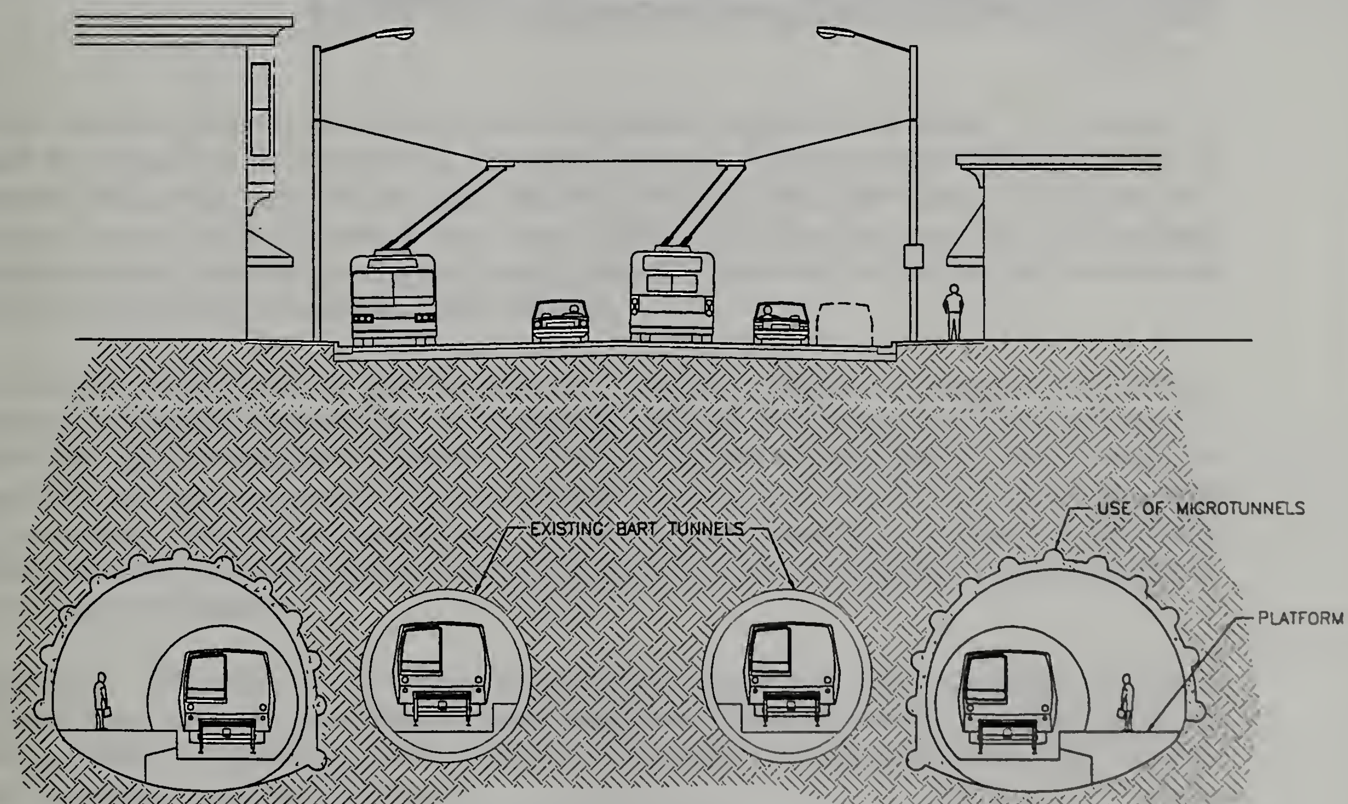


STAGE I

STAGE II–COMPLETE

ALTERNATIVE 'A'

FIGURE 7-E



CROSS SECTION A–A
TUNNELED STATION–PLATFORM SEGMENT BENEATH BUILDINGS

ALTERNATIVE 'B'

FIGURE 7-F

30TH & MISSION BART INFILL STATION STUDY
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A considerable amount of the property needed for construction would be obtained from the Safeway parking lot. However, most of the Safeway lot and other properties could be restored to previous types of use following completion. Some of these evacuated parcels are along the east side of Mission and would remain buildable for new structures along a new set-back after the station completion.

FIGURE 8

Certain details of property acquisition must await further progress in the design. For example, it would be desirable to develop several pedestrian entrances to the new station from each side of Mission Street at the north end, the south end and along the sides of the station. Such entrances are more convenient for patrons if they extend further away from the street so as to facilitate pedestrian access without crossings of nearby streets. However, to develop such convenient entry points, more right-of-way would be required.

To minimize right-of-way for station entrances, it might be possible to integrate one or more entrances into adjoining buildings. A photograph of such an entrance is shown in Figure 8. Usually this type of treatment is limited to a larger or more modern building. Thus it might be feasible for use with some of the new replacement building that could be built over and around the new station after station completion. It might also be possible to connect new adjoining buildings directly from their basement levels to the new station mezzanine. These concepts are called 'joint-development'.

<u>Alternatives</u>: Alternative 'B' would require more substantial width than Alternative 'A' due to the extra space needed to construct the new platforms completely outside the envelope of the existing tunnels. Accordingly, there would be an increase in overall width needed and an over-wide mezzanine would also be a result.

6. CONSTRUCTION IMPACTS AND SEQUENCING

Construction Methods

As indicated above, the majority of the construction of the BART underground facilities would be accomplished away from the pre-existing operating tracks. Only during construction of the tunnel merge locations and track connections would BART operations be affected.

Utility Relocation: Relocation of utilities is usually the first construction work to be initiated. In general, certain of the smaller utility lines, such as water and gas pipes that function under pressure, and also most electric utilities, are rerouted around the excavation site where possible, or supported from the shoring. Larger utilities such as major sewers that operate by gravity flow cannot be easily rerouted so instead would be reinforced in situ, underpinned and supported by attachment to the shoring framework. Utility relocation would be less for Alternative 'A' and more for the alternatives with the larger pit excavations.

Excavation and Shoring: The station box structures themselves, which would accommodate the station platform and mezzanine and also the north tunnel-merge structures, would have to be constructed by cut-and-cover means. This is the same method that was used to construct the other original stations along Mission and Market Streets. Under the conventional method, steel pilings (soldier piles) are drilled and installed vertically from the street surface around the periphery of the station site. The piles are then in-filled with timber lagging materials to retain the earth. Another conventional method, Bentonite slurry wall construction, is very costly and has environmental disadvantages.

A newer excavation method that has been developed and used in recent projects could be applied to this construction. This technique is called 'soil-mix' technology, and was developed by the Japanese company, Seiko Kogyo Company, Ltd. This method has been previously used on at least one other BART project and also on the Islais Creek project in San Francisco.

With soil-mix construction, the walls of the site excavation are created by drilling a row of closely spaced holes, which are filled by a mix of injected cement and native soil. These walls would penetrate about one-third deeper than the invert slab (bottom floor) of the completed station.

The soil-mix method could be used instead of the more conventional soldier piles, because it has the following advantages:

- The soil mix walls are thinner than conventional ones, thus saving space and right-of-way
- The construction shoring can be used as a component of the formwork for the later concrete pours used to create the new station walls
- The construction shoring can become part of the permanent structure, thus saving both space, time and cost by obviating the need to extract temporary steel piles or timber lagging

- This type of construction is nearly waterproof, so continuous pumping out of ground water seepage and silt is greatly reduced
- Cost of the soil mix construction is not substantially greater than conventional soldier-pile and lagging methods. It is less expensive than the Bentonite slurry wall method.

Due to the extreme depth of the southerly tunnel-merge location, excavation of the large pit shown in Figure 7-D, all the way down from the surface might not be feasible or desirable. If such is the case, the underground excavation would need to be accomplished working mostly from below. This would be facilitated by one or two relatively small-diameter access shafts bored down from the surface. The shafts would be used for construction access and material removal. Such shafts could be bored beneath Miguel Street, thus keeping building takes to a minimum. The exact requirements for this are subject to further study.

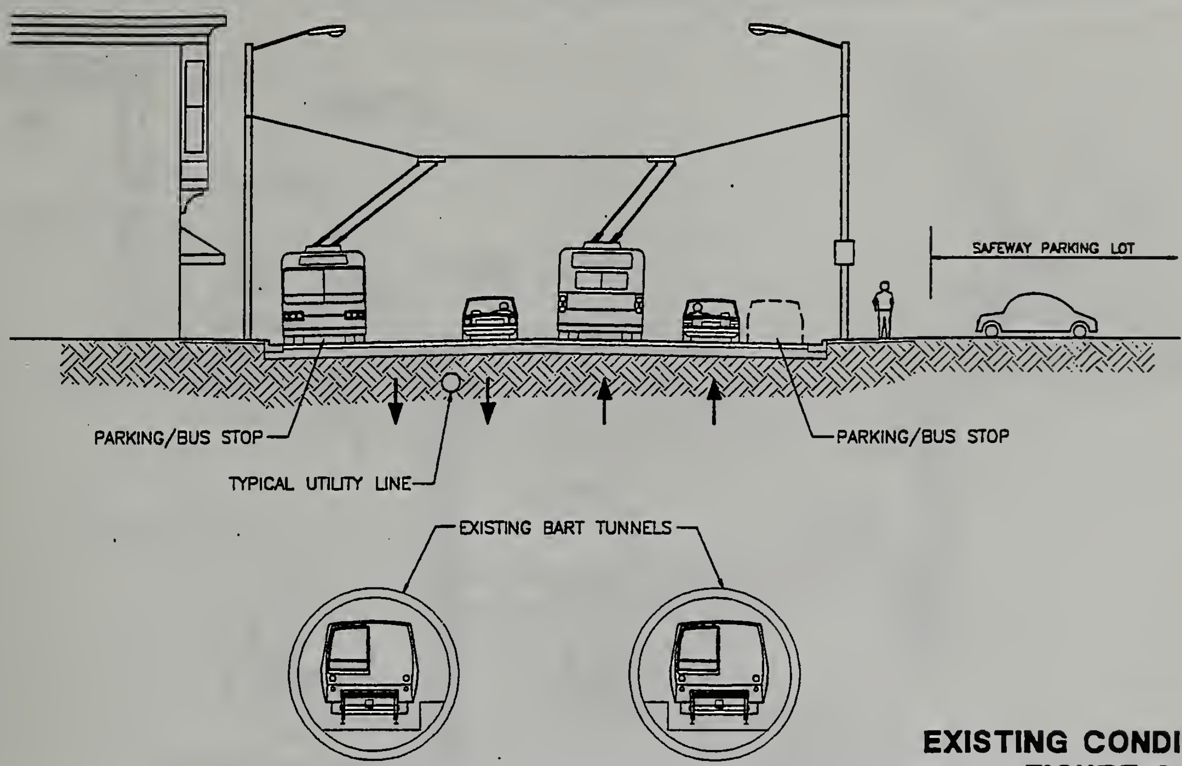
All the excavated earth material from the pit excavation and the bored tunnels would be lifted to the surface and removed from the site in dump trucks. This operation would occupy substantial space at street level and generate significant traffic.

<u>Temporary Decking</u>: When completed, the drilled walls of the main excavation would be tied together with a steel framework of spreaders, 'walers' and girders, which would then be used to support a temporary timber deck for vehicular traffic and pedestrians. During this time, any utilities not already relocated would be underpinned or tied to the temporary shoring structures. Meanwhile, further excavation would proceed beneath the deck to the full station depth.

The temporary timber decking is usually first constructed along one half of the street at a time, and during a period of about one year, street traffic would have to be constrained to one lane in each direction. On-street parking would be prohibited during the entire project. Temporary poles would be used to support traffic signals, streetlights and the MUNI trolley bus wire system. The methodology for all this is well-tested and was used for previous construction on the original BART Mission and Market Street stations.

Staging and Sequencing:

The Figure 9 series of illustrations show the basic sequencing of construction of the main pit at the Safeway parking lot. This sequencing is for Alternative 'A', with Alternative 'B' being similar, although not identical. First, utilities are relocated. Figure 9-A shows the next stage during which the soil mix walls are drilled along one side of the street and along the center of the street, followed by excavation between them as in Figure 9-B. Then as shown in Figure 9-C, a temporary deck would be constructed along one half of Mission Street while two lanes of traffic are rerouted onto the other half of the street. Excavation would proceed below. After traffic can be redirected onto the completed temporary decking, the second half of the street would be drilled and decked as in Figure 9-C and 9-D. The excavation could then proceed to completion beneath the full-width temporary decking, and at that time, also as shown in Figure 9-D, all four traffic lanes could be restored to Mission Street. Sidewalks could similarly be maintained using decking, with some rerouting around the periphery of the excavation.



EXISTING CONDITIONS
FIGURE 9

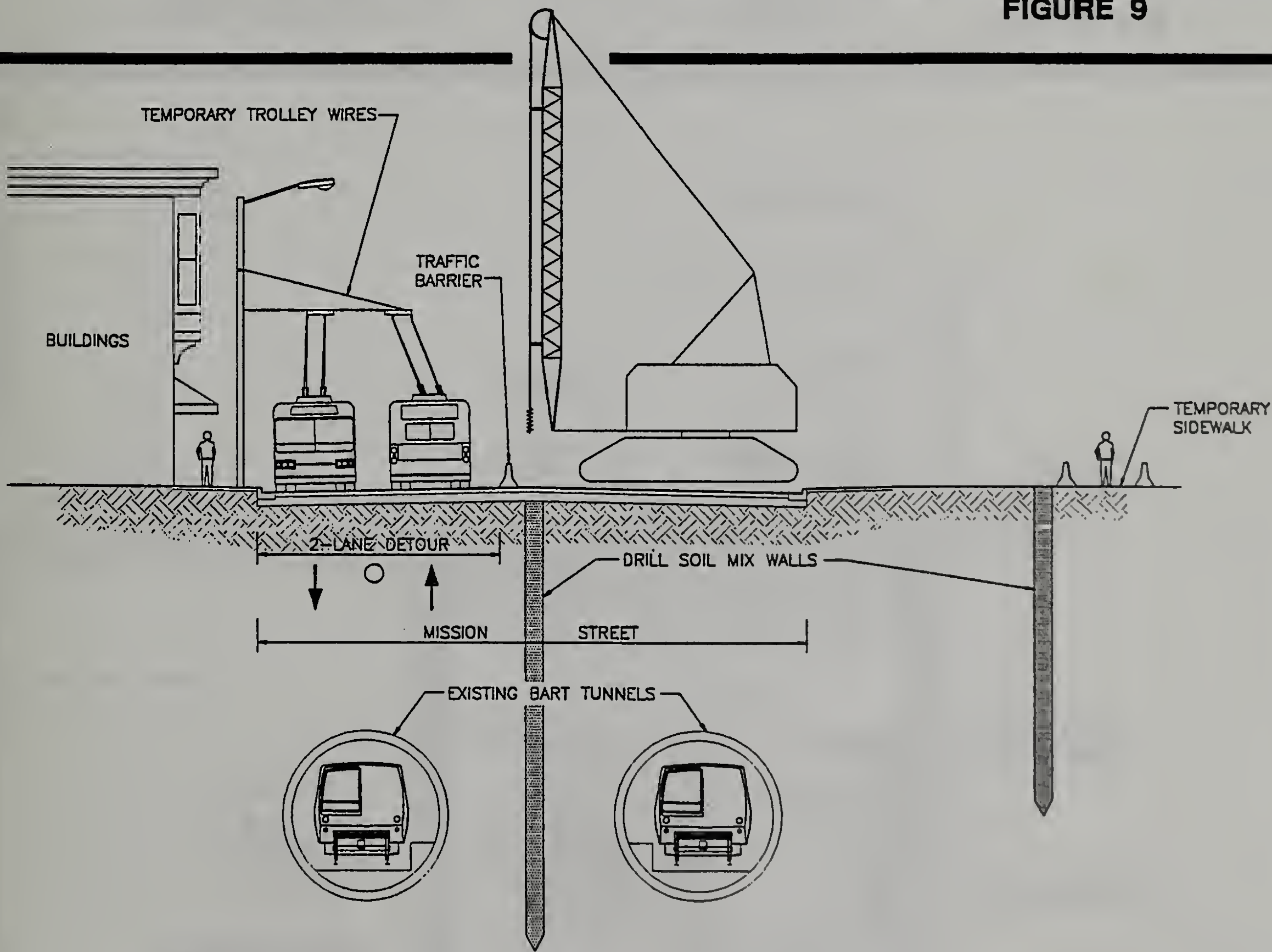


FIGURE 9-A

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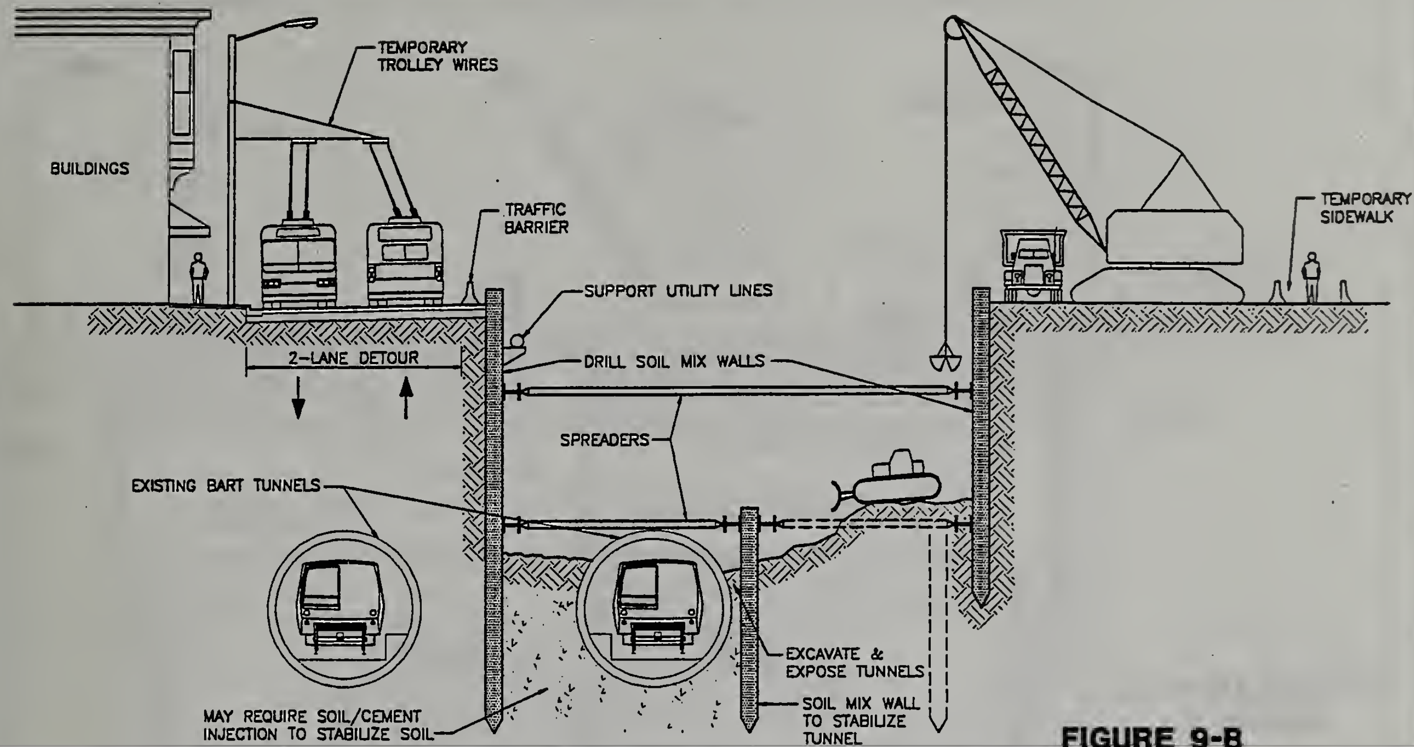

FIGURE 9-B

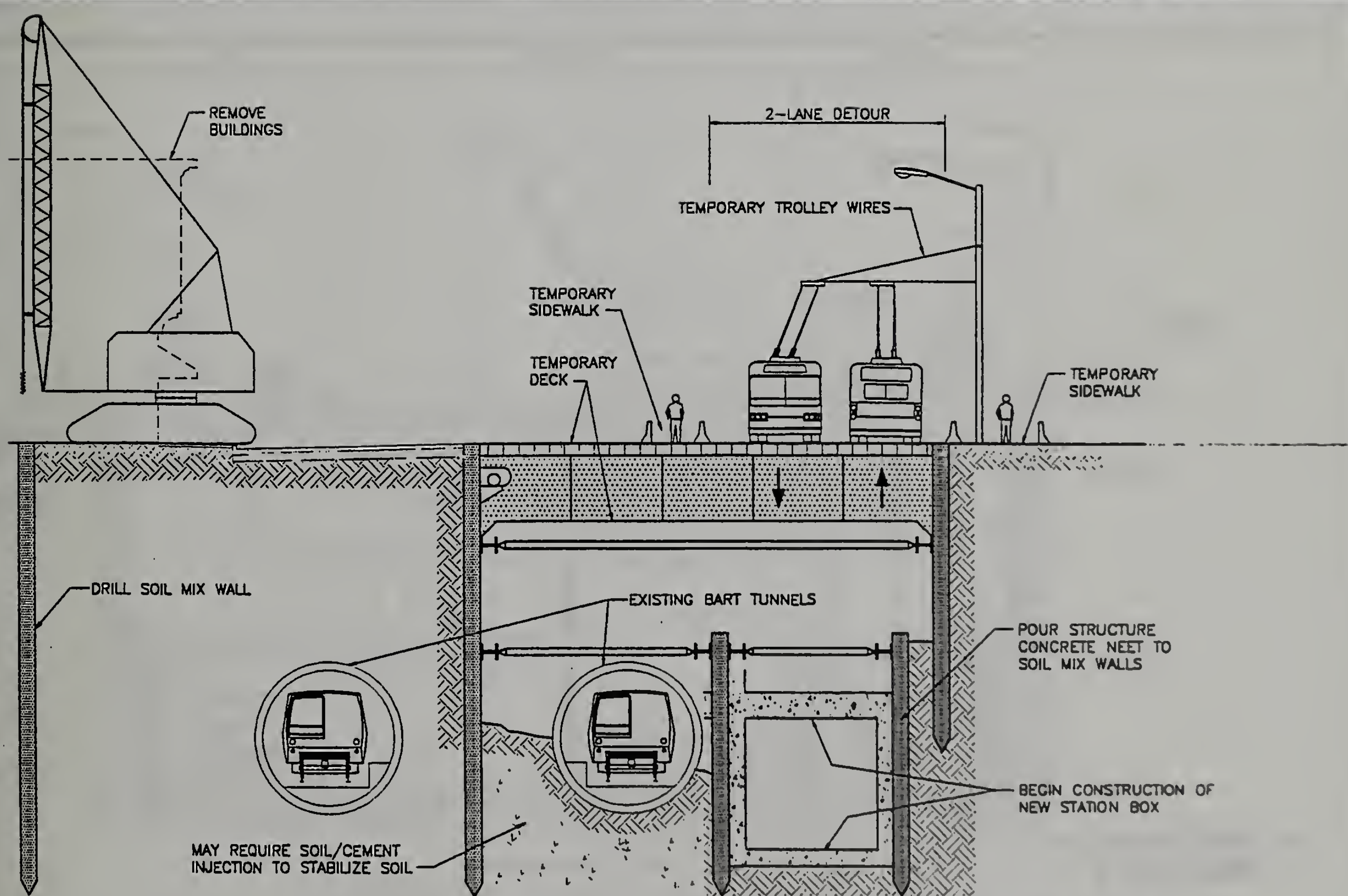

FIGURE 9-C

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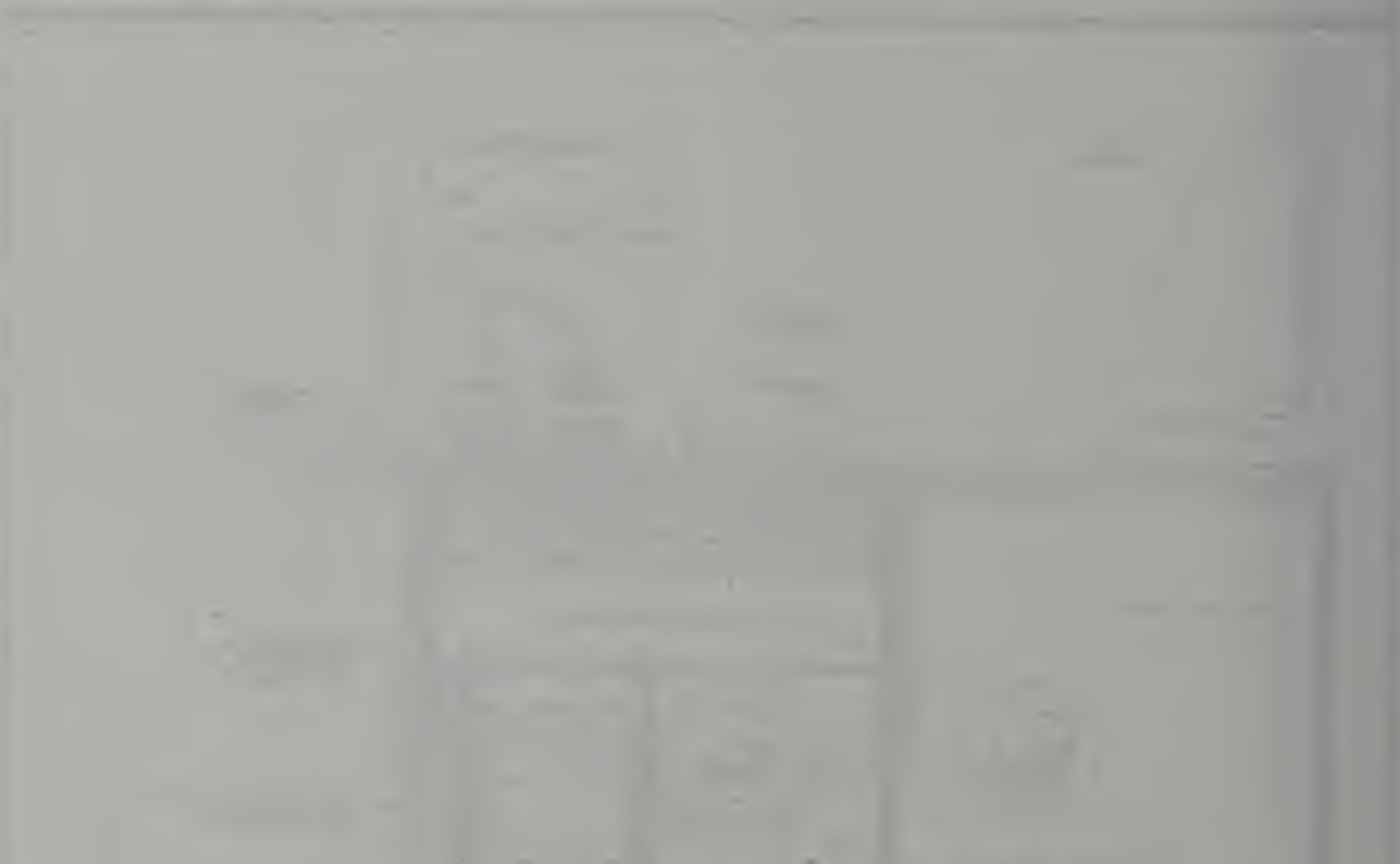
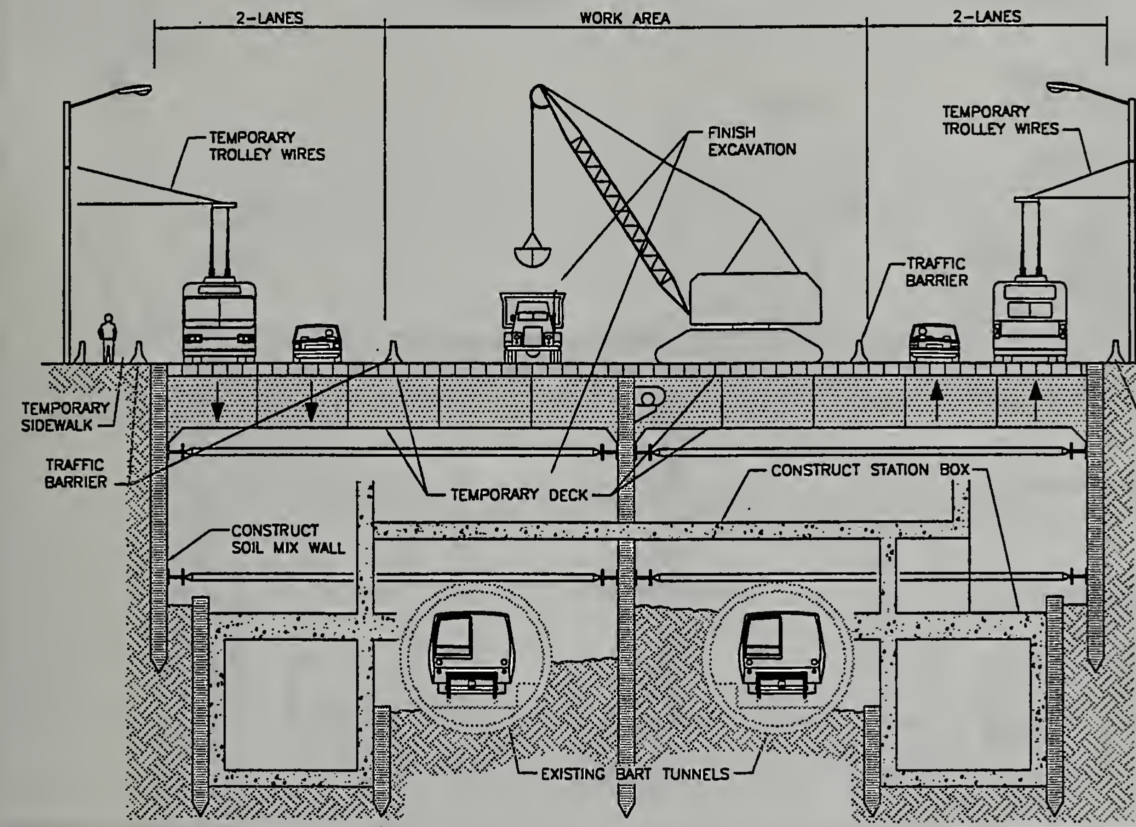
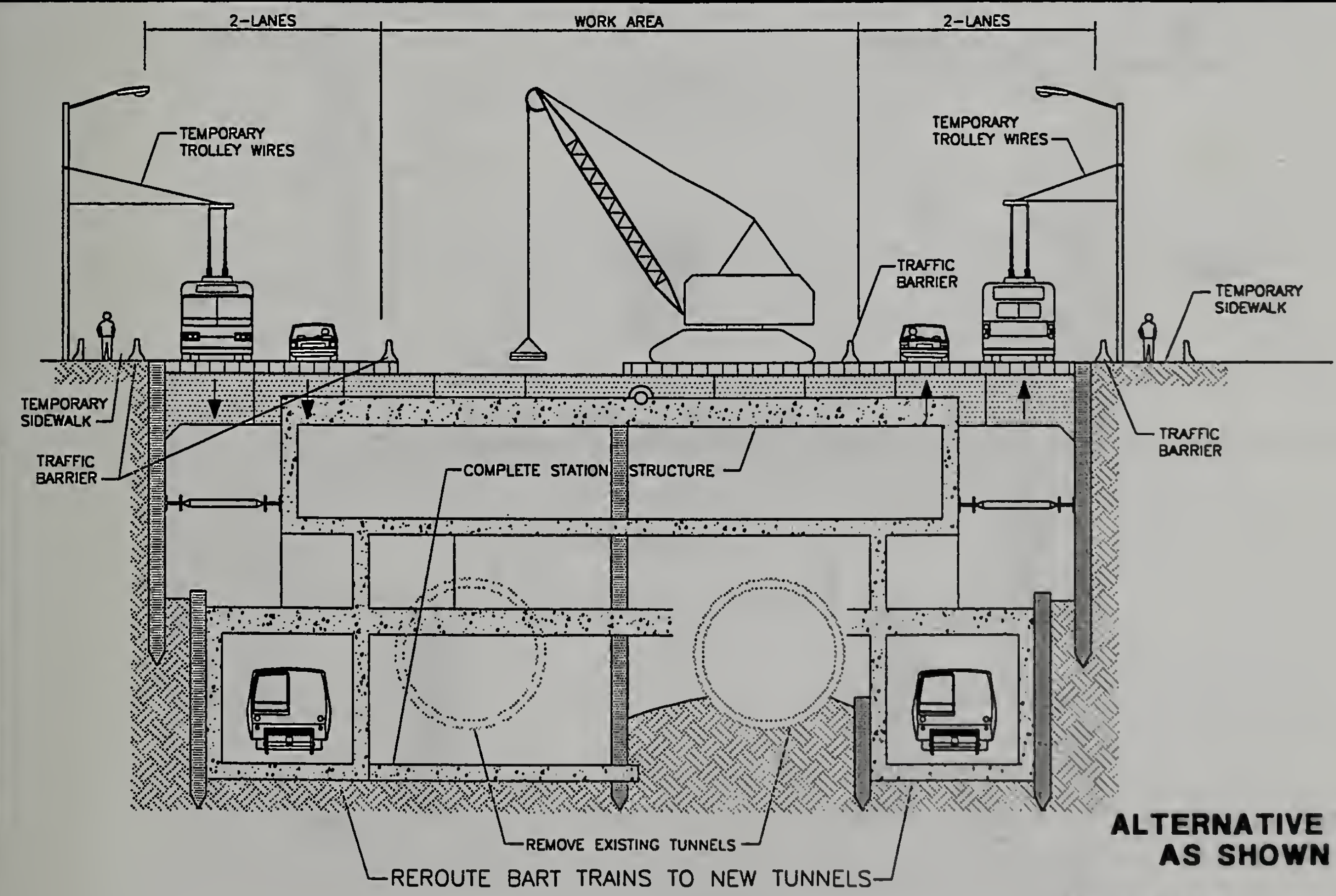




ALTERNATIVE 'A' AS SHOWN

FIGURE 9-D



ALTERNATIVE 'A' AS SHOWN

FIGURE 9-E

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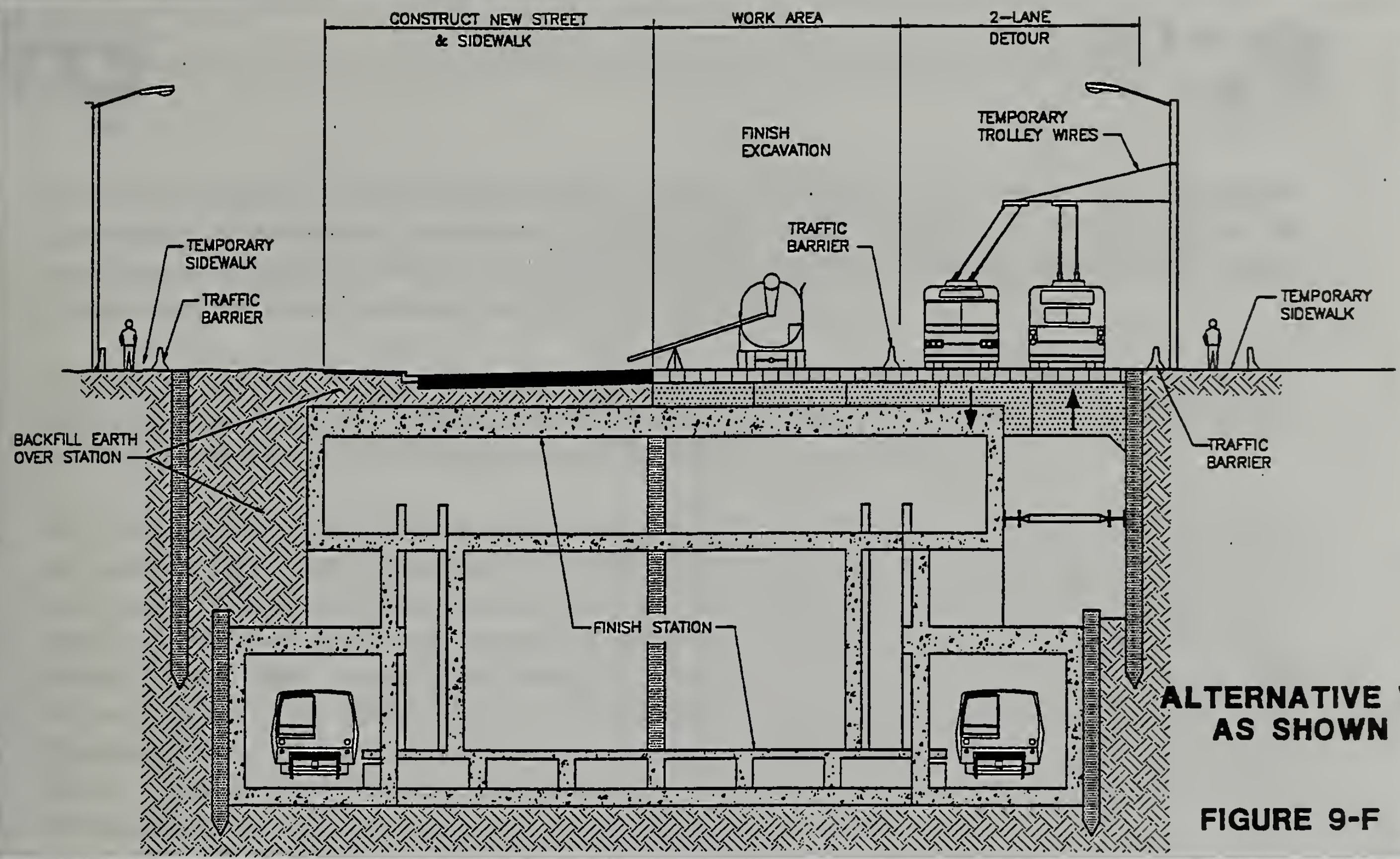
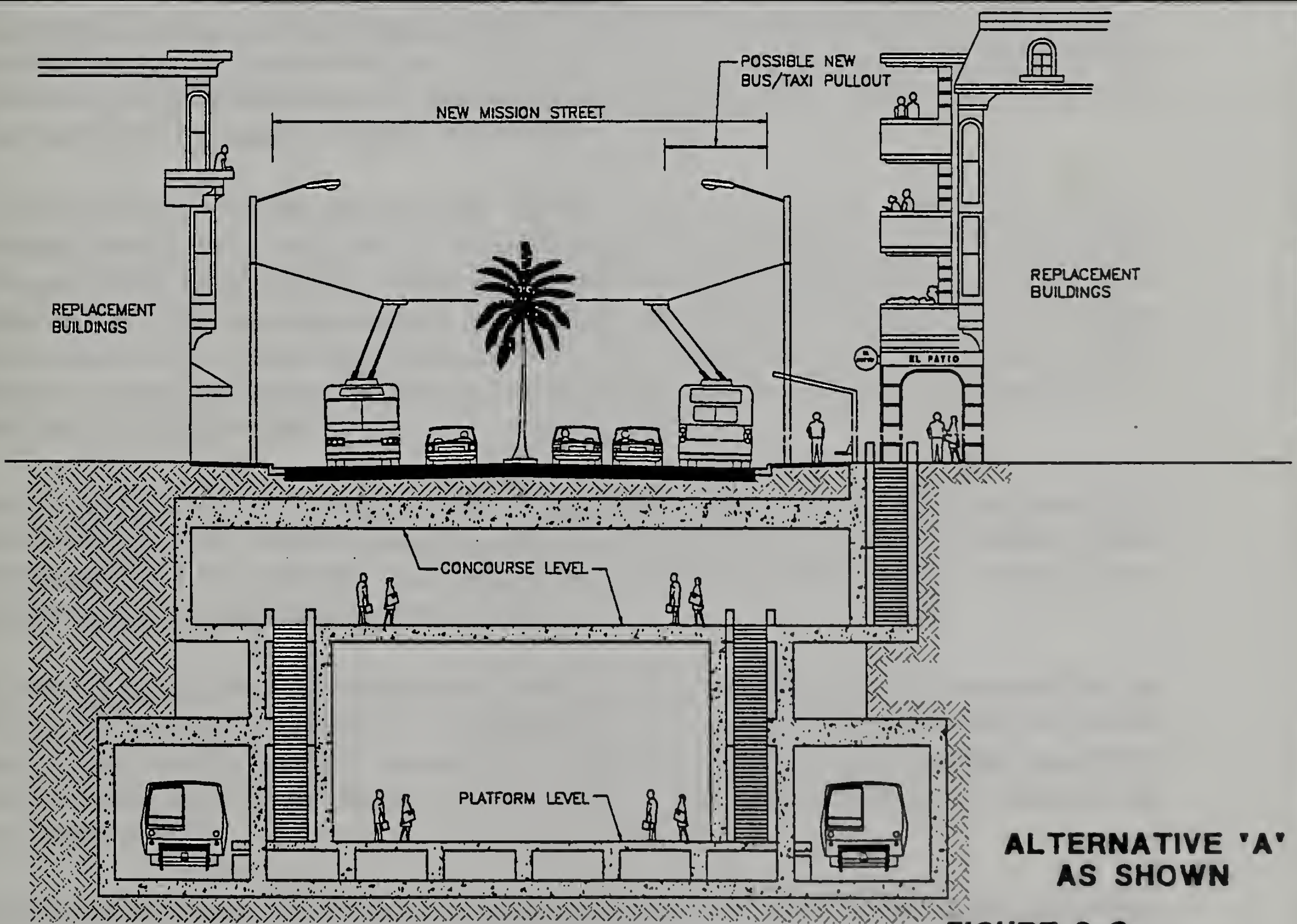


ALTERNATIVE 'A' AS SHOWN

FIGURE 9-F



ALTERNATIVE 'A' AS SHOWN

PROJECT COMPLETE

FIGURE 9-G

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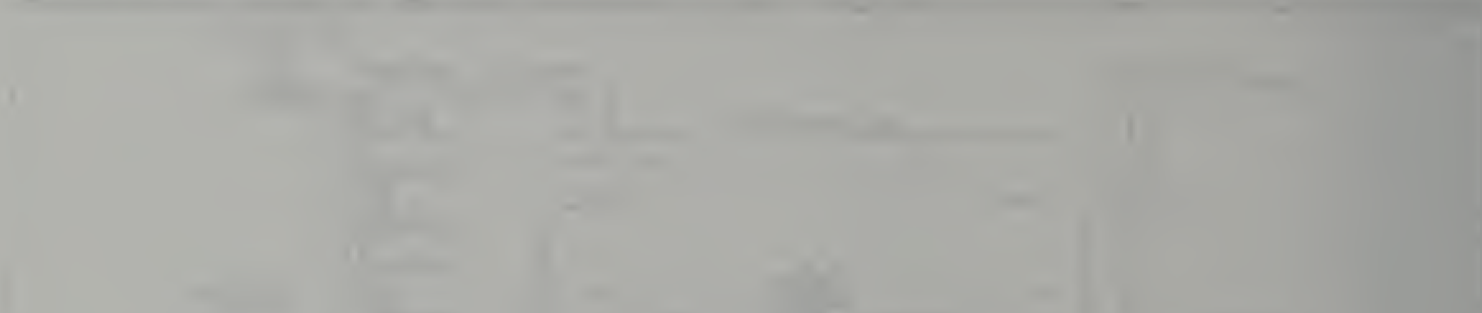

After the excavation had reached its full depth, the bottom slab, walls, roof and other components of the station box structure would be formed and completed. Also at that time, the two tunnels between the station excavation pits and between the station and the south merge location would be bored outward from the main excavations.

In order to stabilize and protect the existing BART tunnels during construction of the station, soil/cement grout mixture would be injected beneath and around the tunnels. Additional soil-mix walls might also be drilled along the sides of the tunnels to protect them.

For Alternative 'A', construction of the station box would proceed as shown in Figure 9-D with the existing BART tunnels retained in service while the mezzanine level above was constructed over them. This would permit advancement of the work to complete the station shell and also rebuild the surface street independent of progress on the new tunnels, structures and tracks below. Thus there would be no schedule dependency (i.e., no 'critical path' relationship) between rerouting the BART trains to the new tunnels (as in Figure 9-E for Alternative 'A') and finishing the top of the box structure in order to backfill the excavations and restore Mission Street. After the BART trains could be rerouted to the new tunnels, the station platforms could be completed.

<u>*Tunneling and 'Cut-In' to the Existing Tunnels:*</u> The new southern approach tunnels would be constructed from below grade so that the surface could remain undisturbed. The large-diameter bores between the main excavation pit and the north pit, and also the segment just south of the main pit would also be tunneled as shown in Figures 7-E and 7-F.

The south approach tunnels are smaller diameter but may not be sufficiently long to economically justify the use of a special tunnel-boring machine (TBM). A TBM can bore faster and cheaper than manual mining. However, a TBM is itself costly, takes about one year to manufacture and also requires adequate space for its launching and extraction. The project configuration would not permit easy extraction of a TBM at the south end. Use of a single TBM would also require that the two tunnels be bored consecutively rather than concurrently, thus doubling the time requirement.

However, with an access pit or access shafts at the south tunnel merge location, extraction of a TMB would be feasible. Manual tunneling would also be facilitated by south pit surface access, as the tunnels could be excavated from both ends toward the middle, on four working faces. This would cut the manual tunneling time in half.

At the extreme ends of the new tunnels and trackage, these would have to be connected into the existing tunnels as shown in Figure 10. When complete, the new work must be switched over to or 'cut-in' at the limits of the new construction. There are two such locations along each track direction, totaling four 'cut-in' merge points. Each of these would resemble a branch in the tunnel configuration.

The merge construction of the project is highly problematic as it involves potential interruption of train traffic and single-tracking of train service while the work proceeds. The underground

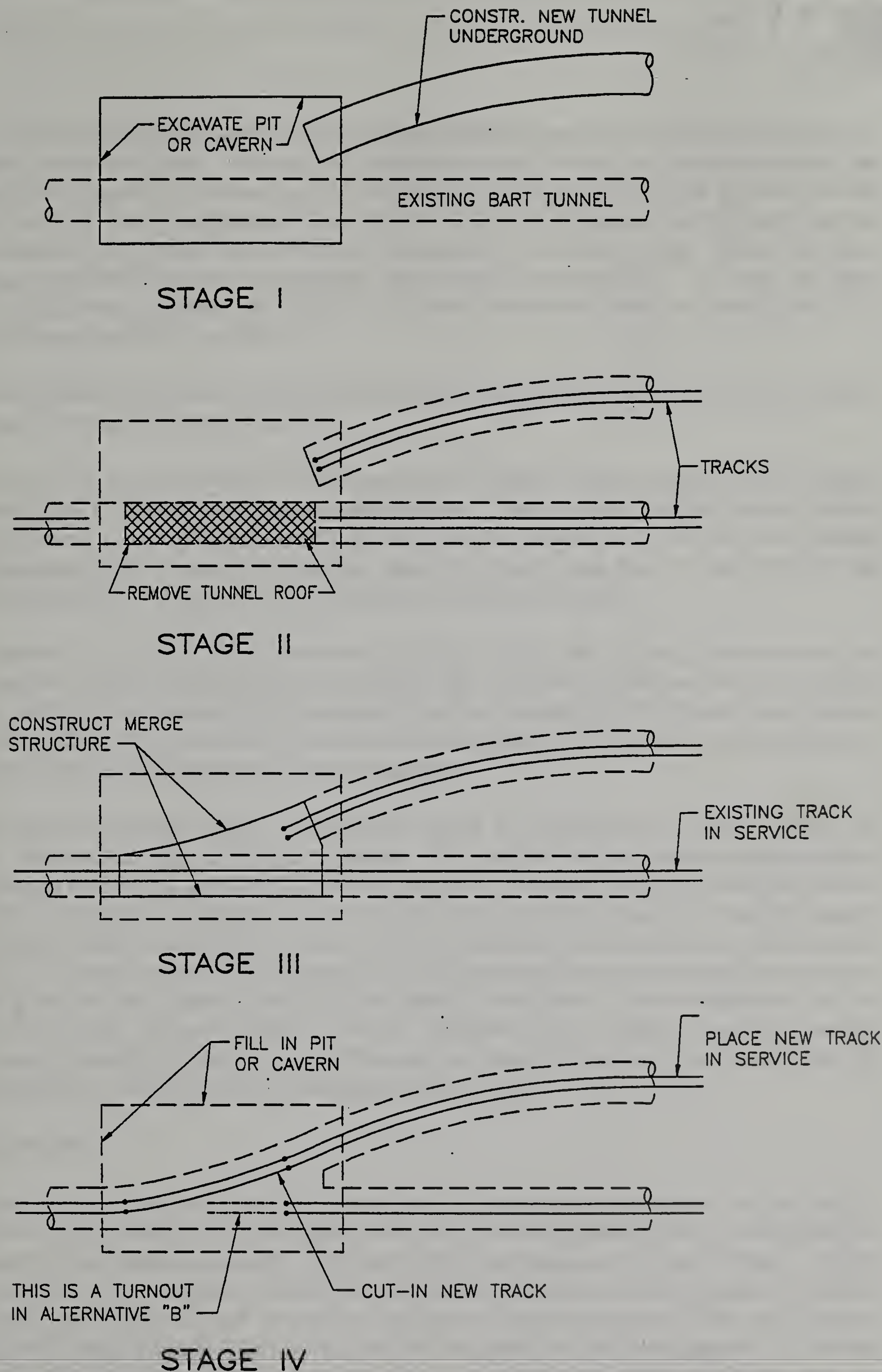

FIGURE 10

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location of all the construction also entails extreme difficulty because work area is limited and work access is very awkward. Much of the construction work at the four merge locations (and also at the track crossover of Alternative 'B') would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended during very limited schedule windows or during single-tracking operations. Needless to say, this is a major disadvantage, and BART service interruptions would need to be minimized. To do so, the basic approach would be to minimize the size of each merge location as much as possible so as to permit its quickest possible construction.

(Further description of the BART service interruptions, single-track operations and bus service substitution is included a following section.)

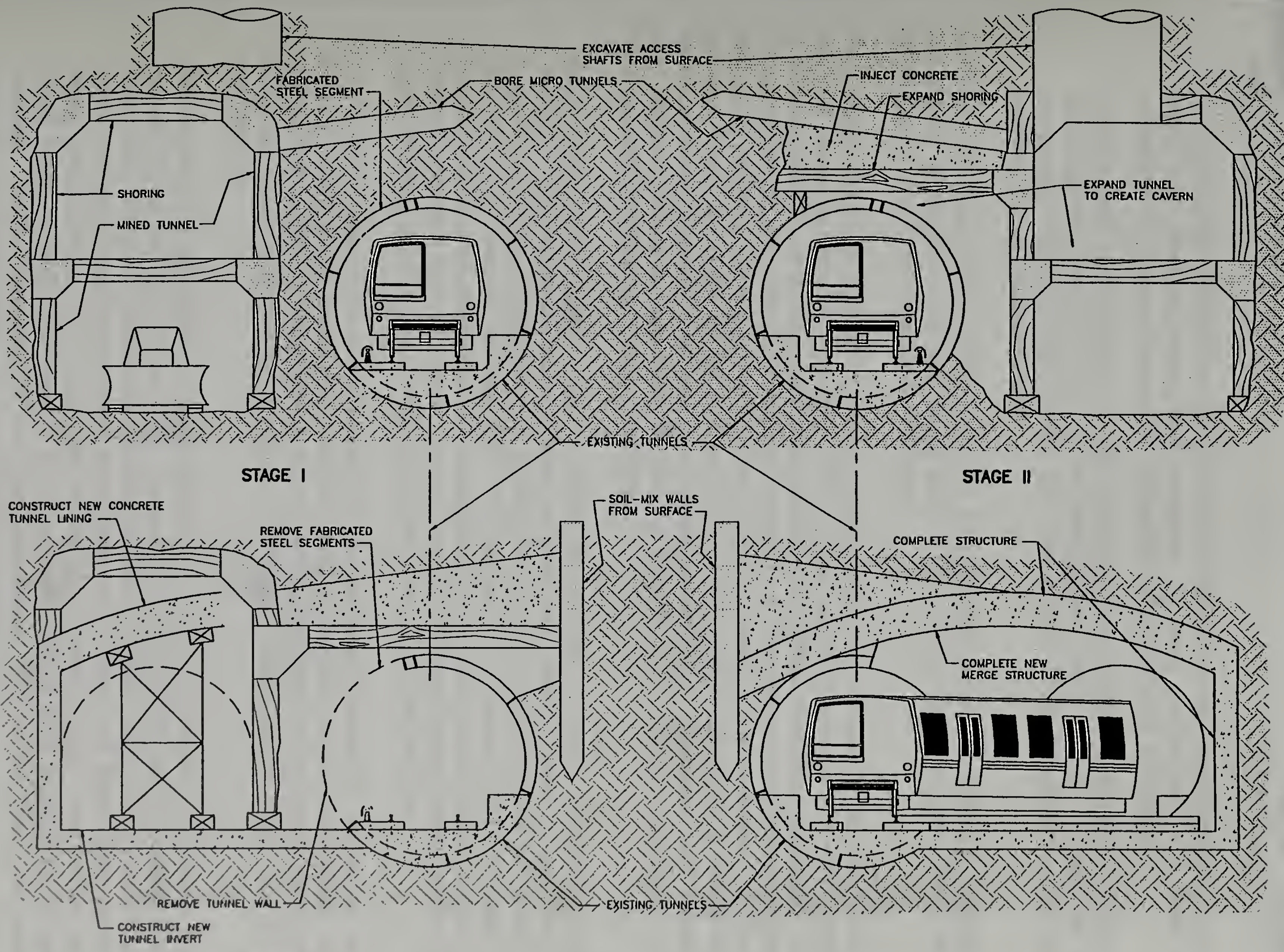
Before the main work could proceed at the tunnel merge points, certain existing BART systems would have to be rerouted away from the work zones. These features include electric power distribution cables, communication and signal lines and the conduits and raceways that contain them. Segments of the concrete emergency walkways would also have to be removed and replaced with temporary timber walkways through the construction areas.

At each location, as shown in the sequence in Figure 10, first the existing tunnels would be exposed and the tunnel roofs removed. For safety, the latter work could be done only during suspended service or reduced-service windows. The new structure of the tunnel merge would then be constructed. This work, which is over and immediately adjacent to the operating tracks, would also be limited to times during service suspension.

The track merge locations north of the station would be constructed in a box similar but somewhat narrower than the main box structure. The southern merge location is more distant from the station and also at great depth below the surface. So these merge points might have to be installed in specially excavated caverns if a large pit is to be avoided. Instead, smaller diameter shafts would be bored from above. Then to construct a cavern as shown schematically in Figure 11, the earth above the existing tunnels might first need to be consolidated by injection of cement grout or other special materials by drilling from above. Other techniques such as insertion of horizontal support girders or boring horizontal 'micro-tunnels' laterally over the existing tunnels might be needed as well. These are complex, difficult and costly tasks, and the special requirements for them would be subject to further study.

Track Construction:

Construction of the trackwork and its foundations at the 'cut-in' locations would also be especially difficult. Construction and replacement of in-service railroad track is not uncommon, and the conventional method is easily facilitated where the trackage is on the surface. In such cases, a section of track such as a complete turnout is prefabricated as a unit together with all its crossties, and installed as a 'panel' to replace a segment of pre-existing track. The use of panels facilitates quick replacement of track so that service interruptions can be minimized. However, in this case of the underground BART tunnels, the conventional methodology is inadequate due to two major limitations:



CROSS SECTION AT SOUTH TUNNEL MERGES

FIGURE 11

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FIG-11 DWG

FIGURE 11

- The space available within the tunnels is so constrained that only small track components could be handled and maneuvered into place. It would not be feasible to install a complete # 15 turnout as required for Alternative 'B' in one piece, at one time.
- The foundation configuration and the fixation hardware needed to support a turnout is much different than provided by the existing track slab. Yet it is impossible to completely and immediately modify the existing slab without disrupting the rails and causing long service interruptions.

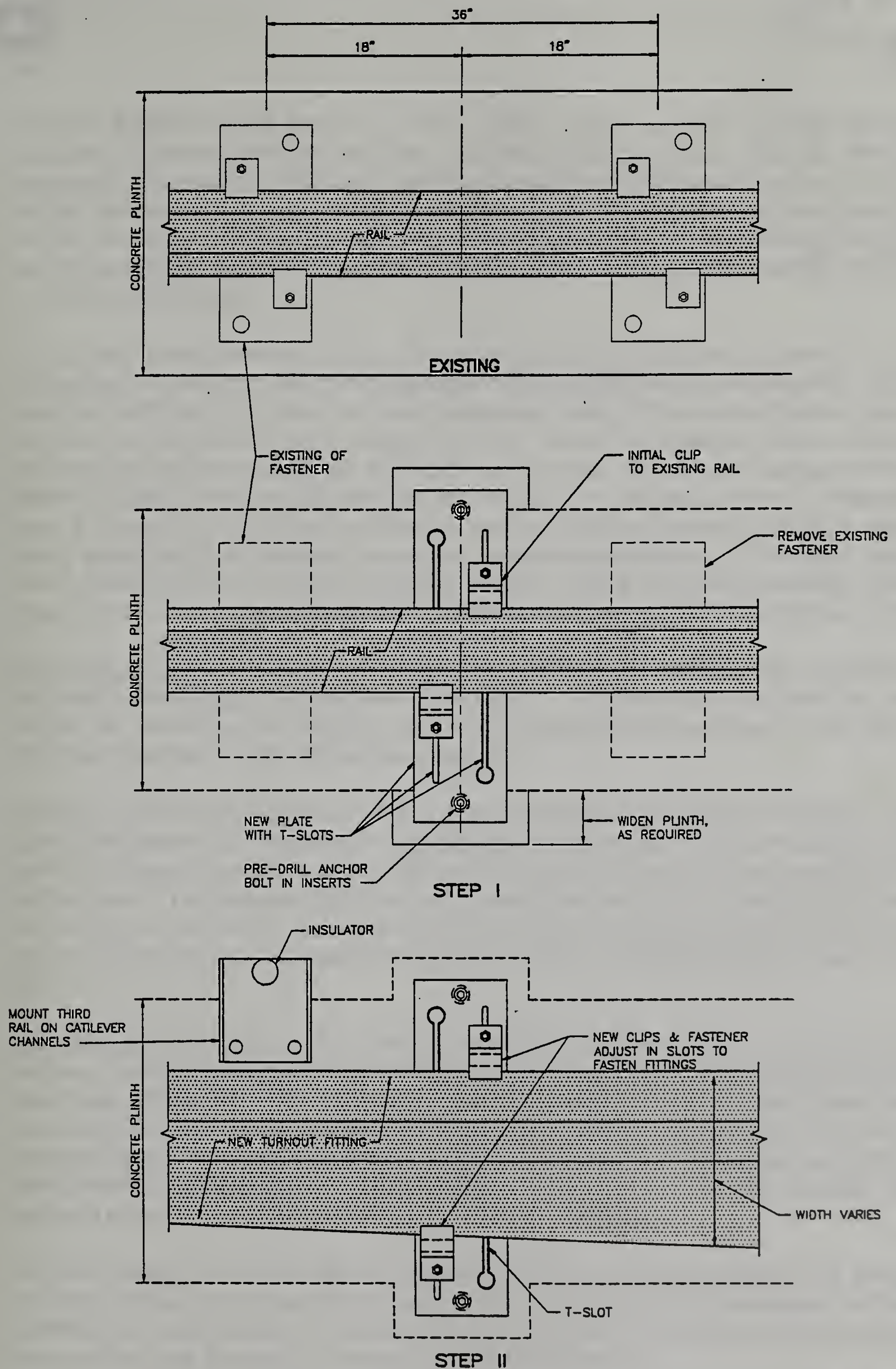
Therefore, replacement of an entire turnout as a single panel would be infeasible. Instead, construction of the new trackwork would have to be advanced piece-by-piece during the available short-time service interruption windows.

There appears to be three possible means to modify the trackwork and these are described below. This work would be preceded by removal of the adjacent concrete walkways and raceways and by electrical isolation of the track construction zone by installation of insulated rail joints. The continuous electric power third rail would be replaced by a discontinuous power rail with gaps; these being defined as the longest permitted under BART standards. (These shortened third rail segments would be supported on jigs so as to be easily and repetitively disassembled, manipulated and replaced during subsequent trackwork activities.) Trackwork modifications could be accomplished by these methods, working from the side of the track where the new tunnel excavation had been previously completed:

1. <u>*Modify Track Slab Fixation*</u>: This would be the preferred approach. The existing rail fasteners which support the rails are located on three-foot centers. These are supported by (second pour) concrete plinths about 32 inches wide, which are raised about six inches above the (first pour) concrete trackway slab. The existing direct fixation (DF) rail fasteners include plates that are about eight inches lengthwise by 14 inches crosswise with respect to the rails, and about two inches thick. Two bolts hold each fastener to the concrete plinth and two more bolts, which extend upward, affix the rail to the plates with rail clips.

   The existing fasteners are not designed to accommodate the special fittings of the new turnout. New longer-slotted rail fasteners would be needed to affix and support the switchpoint, the frog and the guardrails of the new turnouts. Also, additional fasteners would be needed to support the two additional rails (curved stock rail and curved closure rail) of the new turnouts.

   Between each pair of adjacent fasteners along each rail, there is a void about two inches high between the rail and the concrete plinth. It would be possible to insert new rail fasteners into these voids between the existing rail fasteners as shown in Figure 12-A. To accomplish this, these voids might need to be chipped away slightly to increase their depth. The concrete plinths would also need to be augmented as needed to broaden them. Next, anchor bolt inserts would be drilled and installed in the widened plinth at each location for the new fasteners. The bolt inserts would be drilled on each side of the existing rails, but placed further away from the rails than the existing rows of fastener bolts.



USE OF T-SLOT RAIL FASTENERS **FIGURE 12-A**

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The new fasteners would consist of 'T-slot' plates slipped under the existing rails at the positions of the new switches and frogs, and bolted onto the plinths using the previously prepared bolt hole inserts. The long T-slot in each plate could then accommodate a variety of rail and hardware widths by inserting the upper fixation bolts and sliding them laterally as needed. Initially, the T-slot fasteners would be adjusted to support the existing rails. Then the pre-existing DF fasteners would be removed and the T-slot fasteners quickly readjusted for the new rail fittings.

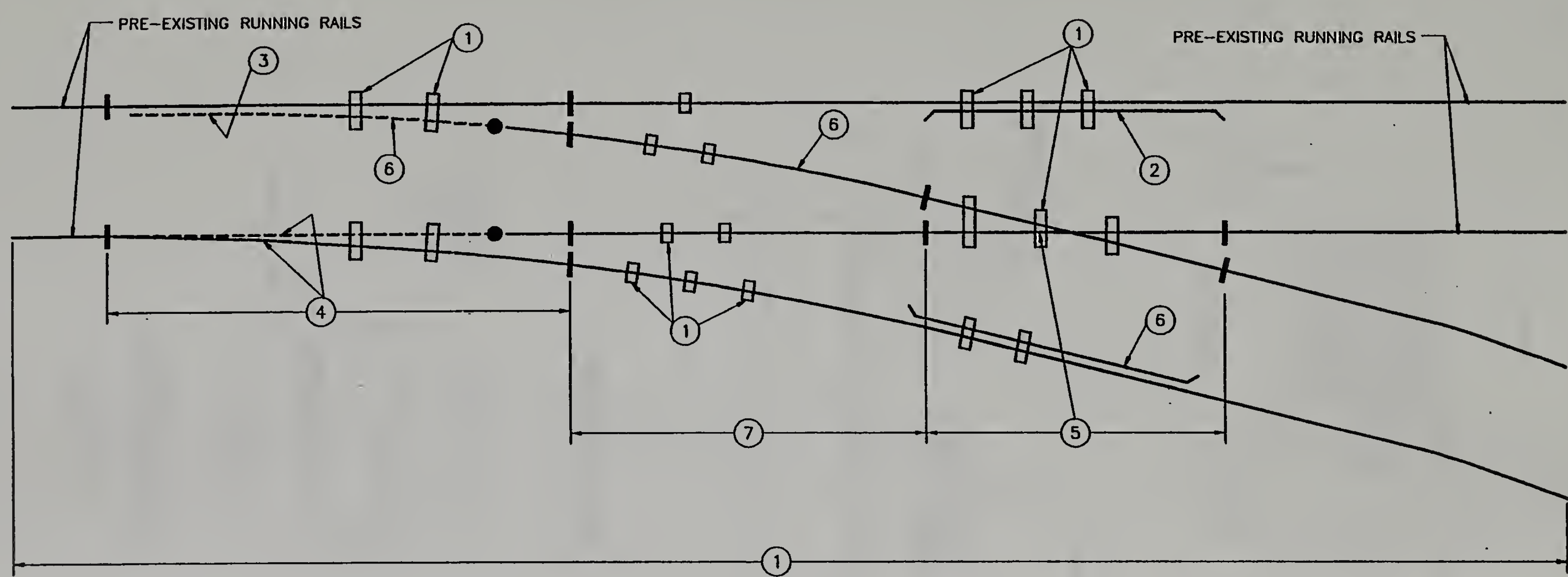
During the above-described tasks, the existing running rails would remain in place undisturbed so that only short evening/night time/weekend service interruption windows would be sufficient to advance the initial preparatory work. When all the fixation hardware had been pre-prepared in this way, segments of rail would then be cut out, one at a time, and replaced with the new fittings for the switch and the frog. The general approach to this is shown in Figure 12-B. At each time that this change-out of the major turnout components is done, a longer service interruption window, such as an entire weekend, would be required during which BART trains would be subject to single-track operations. This would probably occur a total of about 30 times during the project. During each single-tracking schedule window, work would proceed concurrently at all the new turnouts on the out-of-service track.

2. *Use of 'Boot-Ties'*: In the segment of each turnout between the switch and the frog, there are four rails – two straight rails and two curved rails. The curved stock rail and the curved closure rail would be new additions, and in these segments the two curved rails could be placed on 'boot-ties' as alternate means of support.

   Boot-ties, as shown in Figure 12-C, are essentially small (about 12 inches wide by 10 inches thick by 30 inches long) prefabricated concrete pedestals designed to support each rail. Each boot-tie includes a resilient base pad, and the bottom half of the tie is also encapsulated in a rubber 'boot'. The boot-ties could be used in some locations in lieu of full modification of the base plinths needed for the insertion of T-slot plates. However, the boot-ties cannot be used at the switch and frog locations because of the non-standard fixation details needed there.

3. *Conventional Switch Ties*: This option is considered in Figure 12-D. The existing rail fasteners, which support the rails, are located on three-foot centers. By cutting and chipping away voids between the rail fasteners down into the plinths and the track slab, spaces would be created beneath the rails sufficient to accommodate new switch ties. Ties of six-inch by eight-inch dimensions would be inserted one-by-one from the side of the track where the new tunnel excavation had been previously completed. However, a major disadvantage of this approach is the greater depth needed in cutting out the base slab.

   Two new switch ties could be placed in the void between each adjacent pair of rail fasteners. Each pair of ties would consist of a Crosstie 'A' and a Crosstie 'B' as labeled in the Figure. Crossties 'A' would initially be shimmed up to support the two rails and would be affixed to them with new rail fasteners. Crossties 'B' would be left loose.



1. INSTALL NEW RAIL FASTENERS (OR TIES) ALONG TURNOUT (SEE FIGURES 12-A, 12-C AND 12-D).
2. INSTALL MAIN LINE GUARD RAIL.
3. GRIND RUNNING RAIL TO RECEIVE NEW SWITCH POINT, OR INSTALL NEW RAIL FITTING AS IN 4.
4. CUT OUT RUNNING RAIL AND INSTALL NEW STOCK RAIL WITH SWITCHPOINT.
5. CUT OUT RUNNING RAIL AND INSTALL FROG.
6. INSTALL CURVED CLOSURE RAIL, SECOND SWITCHPOINT AND GUARD RAIL AND ALL OTHER COMPONENTS.
7. POSSIBLE USE OF "BOOT-TIES".

FIGURE 12-B

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FIGURE 12-B

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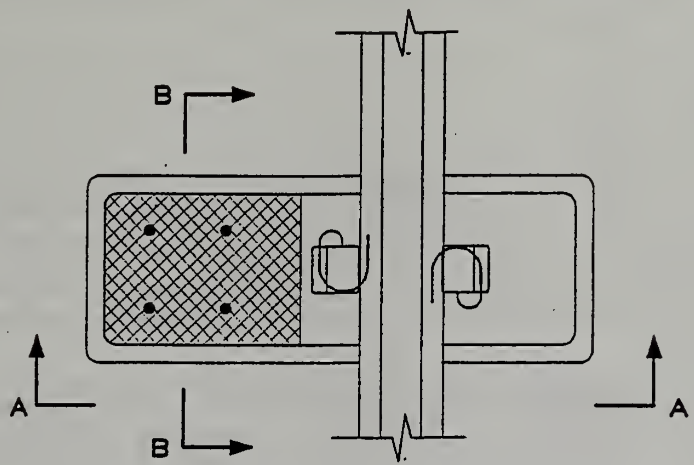
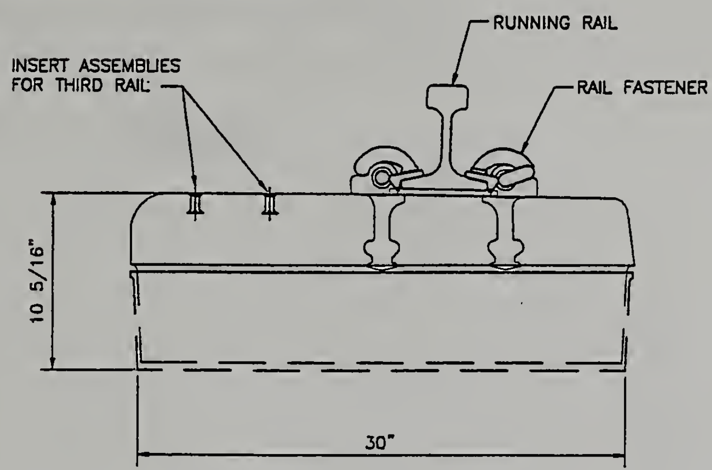
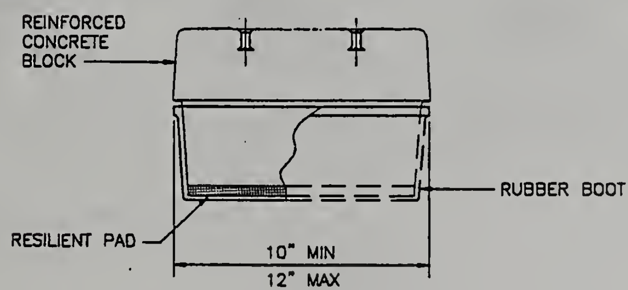
FIG-12b.DWG





SECTION A—A



SECTION B—B

BOOT—TIE

FIGURE 12-C

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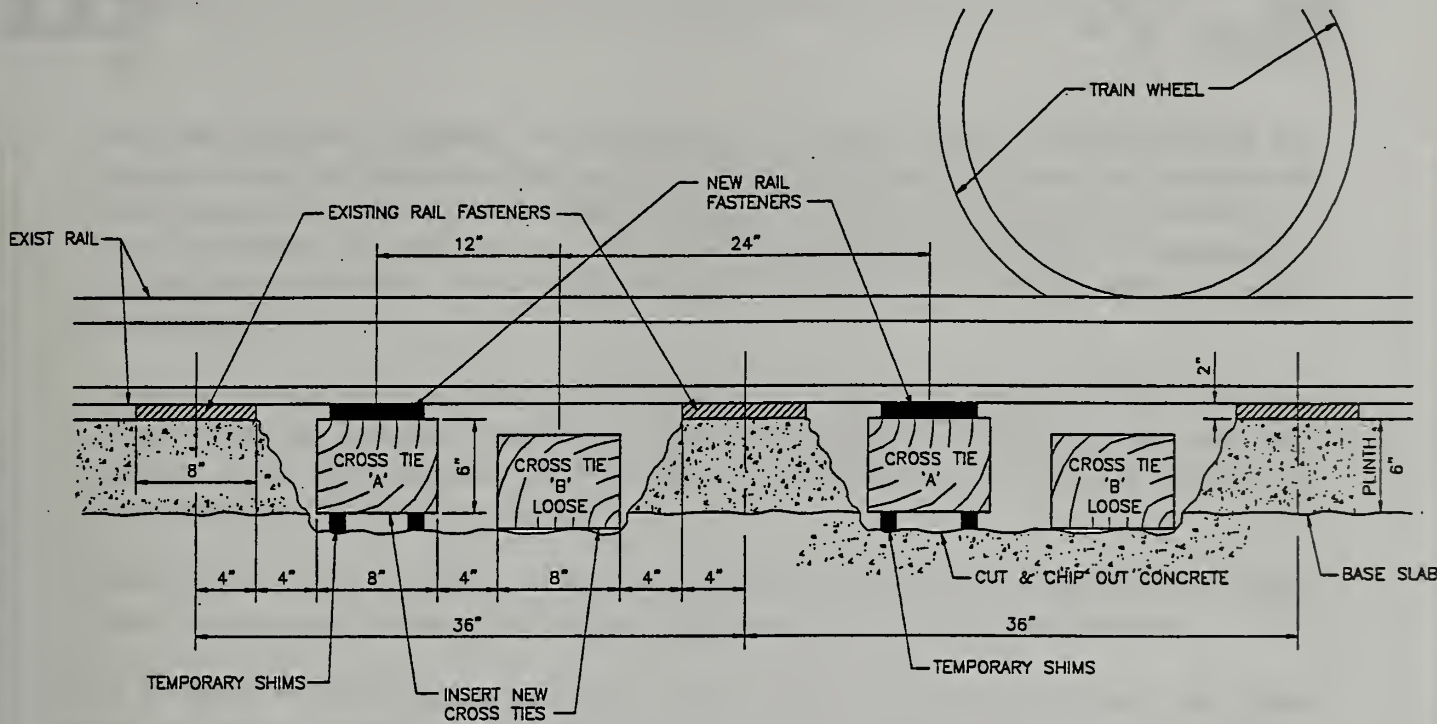
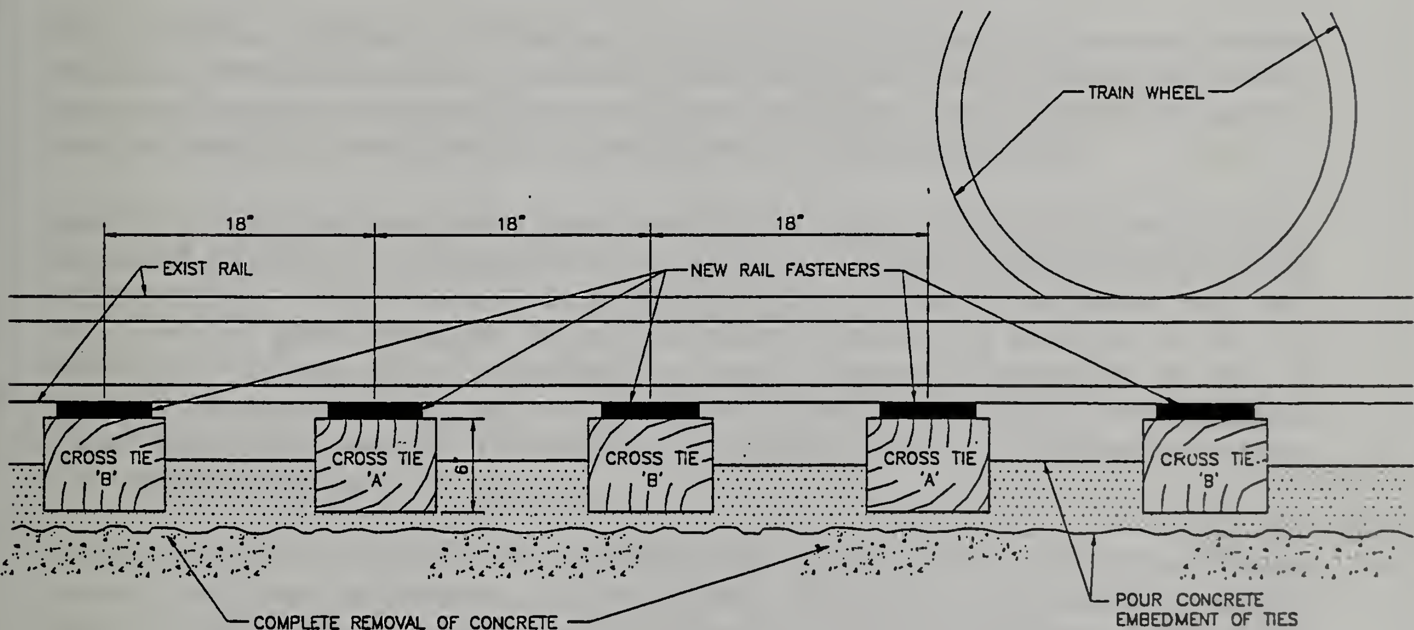


STEP I



STEP II

LONGITUDINAL SECTIONS ALONG RAIL

SCALE: 2"=1'-0"

CONVENTIONAL SWITCH TIES

FIGURE 12-D

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With the rails now supported on Crossties 'A' at 36-inch spacing, the pre-existing rail fasteners would be removed and the remainder of the plinths jackhammered out to extend the voids beneath the rails and make them continuous. At this time, the loose Crossties 'B' would be shifted and respaced along the track. Then these ties would also be shimmed up and fastened to the rails. A new tie spacing of about 18-inches would thus result to support the new turnout.

With the new ties in place, a bed of concrete would be poured around and beneath them to affix them to the base slab. Installation of the remainder of the new components of each turnout would then proceed piece-by-piece as expeditiously as possible during the subsequent construction time windows.

Either timber or concrete ties could be utilized, however, timber ties have the virtue of lighter weight and can also be easily field drilled where needed to affix and adjust fasteners.

All of the above-described options have been utilized before in BART construction. The T-slot fittings and boot-ties were used in the SFO Extension project. Both timber and concrete switch ties have been widely used on BART and are conventional. Appendix 'H' includes some sample engineering details excerpted from contract drawings of similar BART installations.

With any of these methods, all of the proper tie plates and fasteners to support each turnout would have been installed during a preparatory phase during several evening/night time service-interruption windows which would involve single-track operations. Next, the main line guardrail would be installed on its pre-positioned fastener plates as shown in Figure 12-B.

Completion of the trackwork would require weekend-long service interruptions also involving single-track operations. A short segment of the running rail would be cut out to be replaced with the turnout frog. The pre-existing running rail might remain in place as the tangent stock rail, and it could be ground along the rail head as needed to receive the proper fit of the new switchpoint. Or, more likely, a completely new switch fitting could be cut into the rail. A segment of the opposite running rail would have to be cut out and replaced with the curved stock rail and the second switchpoint. The remainder of the straight running rail could remain in place as the tangent closure rail.

Finally, the curved closure rail, the permanent third rail and all the other turnout fittings, guardrail, rods, braces and hardware would be installed. The entire process would thus consist of piece-by-piece operations, each being performed during a train service shutdown. Although this process would be tedious and time-consuming, the same tasks could proceed concurrently on several turnouts at once.

For Alternative 'A', there is no requirement for a turnout, but instead the replacement of the existing tangent track segment with a curved track. Although the track hardware would be less complex than a turnout, the length would be greater because the new curve would need to be of greater radius to support the operations of higher speed main line train movements. However, certain of the above techniques, especially the use of boot-ties, could be utilized to construct the

curved track while retaining the tangent rails in continuous service. The curved track, unlike the turnout alternative, may require some superelevation. This could be achieved after its initial installation by incremental insertion of shims, or raising the boot-ties, to readjust the outer rail upward.

Surface Traffic Detouring and MUNI Routes:

During almost all of the construction period, vehicular traffic, including all MUNI bus routes, could be maintained on the surface of Mission Street on a temporary deck. However, during initial construction of the temporary deck, and again during its removal, traffic would have to be restricted to only two lanes, one in each direction as shown in Figures 9-A, 9-B, 9-C and 9-F. The time during which these detour constraints would be imposed would be less than the full duration of the excavation work but would nevertheless be a significant interruption for each of the two occurrences. On-street parking would have to be prohibited during the entire course of construction in order to free up room for construction vehicles.

During the detour periods some traffic would need to be rerouted to alternative streets. Potential detour routes include the immediate parallel streets, and San Jose Avenue/Guerrero Street might be so utilized. Traffic rerouting to move distant routes, such as Dolores Street, and preferably to Alemany Boulevard/U.S. 101 and to Third Street could be encouraged by signing and adequate publicity. Detour traffic should be discouraged from entering the Bernal Heights area do to the very narrow width of the streets there.

City of San Francisco policy usually promotes public transportation, and during the two-lane detour periods it would be possible to favor the MUNI bus traffic along Mission. All MUNI bus routes, including the electric trolley buses, could be kept operating over the temporarily decked street at almost all stages of construction. To facilitate adequate street capacity for buses, peak hour auto traffic could be limited through the construction site during the two lane detour periods.

Even though two-lane detours would be needed, there are mitigations available to facilitate traffic flow through the work zones. These might include:

- Redirection of through traffic away from the site by signing and publicity
- Provision of full-width (12 or 14-foot wide) detour lanes
- Prohibition of left turns and parking
- Provision of right turn pockets at intersections
- State-of-the-art (optical) traffic signal detection and control during construction
- Relocation of temporary bus stops away from the two-lane detour segments
- Pedestrian fencing to discourage jaywalking
- Improved traffic law enforcement

With these measures, the traffic capacity through the two-lane zones might be kept adequate for all traffic.

The MUNI electric trolley buses can be kept in operation almost continuously. The trolley wires and special work (switches) can be shifted from one side of the street to the other while being supported on temporary poles as shown in the Figure 9 series. The wires can be cantilevered from one side of the street so that cross-street span wires will not interfere with construction. At each change-over, the subsequent wire rerouting would be constructed in advance, and then 'cut-in' at the extremities of the rerouting.

Between wire junctions, the wires are straight tangent runs and each succeeding layout can be constructed parallel to the preceding one without conflict. However, at the wire junctions at the Mission/30th Street and the Mission/Cortland intersections the construction would be more complex due to conflicts between preceding and succeeding wire layouts.

At each stage of wire work at these junctions, the succeeding wire layout would be constructed above the pre-existing wires, which would be kept in continuous service. The trolley bus poles, which press upward onto the wires, would thus be unimpeded while the work proceeds. This method is called 'over-building' and proceeds until the new over-built wires are ready to be 'cut-in'. (This resembles in principle—but on a smaller scale—the BART track 'cut-in' described above). The cut-in of the new trolley wires and cut-down of the old wires can be accomplished overnight or on a Sunday and it would only be at such brief times that electric trolley service would be interrupted. Diesel buses could easily be substituted at such times.

However, construction of overhead wires would entail some traffic lane closures due to use of the street by line trucks. Other interruptions to street traffic would occur during utility relocation. This typically is less time-consuming than the main detour stages but nevertheless is frequently perceived as quite disruptive. Usually this involves occasional lane closures for various periods, installation of temporary steel plates in the pavement and the like.

Property Access and Driveways: During the time that the temporary decking is being constructed and removed, and during the entire duration of its use, property access would be maintained. For pedestrians, temporary sidewalks would be constructed and supported on the construction shoring as needed, or as separate fabrications, or as portions retained from the pre-existent sidewalks where they abut buildings. Adequate pedestrian access to each building would be assured using temporary—usually wooden—structures. These would be configured to permit full handicapped access.

Where vehicular driveways exist, these would be maintained in place and/or replaced with substitute access points. Emergency access must be maintained throughout, and the requirements for this would be subject to approval by the emergency services departments of the City.

Completion of Construction: Once construction of the new tunnels, tracks, and BART system work was completed, the new tracks would be 'cut-in' to the existing BART line and train traffic

rerouted to the new alignment as shown above in Figure 9-E. Portions of the pre-existing tunnels would then be removed and the station platform and mezzanine completed as indicated in Figure 9-F.

When the station box structure is completed, it would be covered with earth and the surface streets rebuilt to the newly designed layout. At that time, street traffic detouring and lane reduction would again be required prior to final completion. The sequencing of this would as shown in Figures 9-F and 9-G.

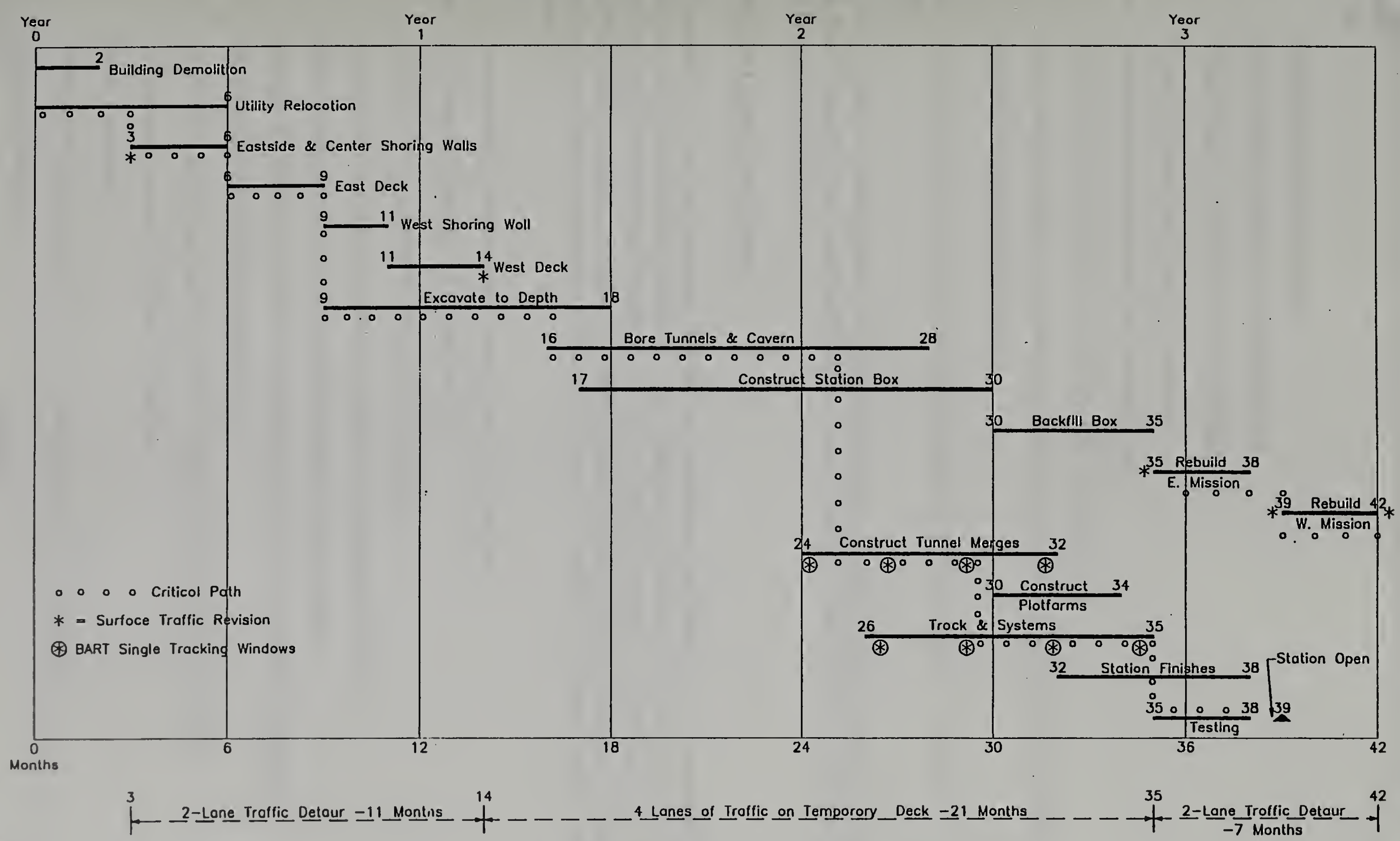
Alternatives: The basic construction staging and impacts of Alternatives 'A' and 'B' would generally be similar. However, there would be some differences. For example, the double crossover of Alternative 'A' as shown would need to be constructed adjacent to, and beneath in-service trackage, and this would multiply service interruptions during construction. The station platforms of Alternative 'B' would be constructed entirely in one stage at the same time as the new tunnels. This differs from Alternative 'A' where the platform construction would be in two stages as shown in the Figure 9 series. At the merge locations, turnouts would need to be constructed for Alternative 'B' instead of the simple track curves of Alternative 'A'. This increased length dimension of the Alternative 'A' curved-track geometry would increase the time and interruption of BART operations during construction.

Construction Schedule:

Figure 13 is a bar chart that illustrates the approximate time durations of the various aspects of the project. The general sequencing would be similar for 'A' and 'B'. The total time requirement from inception of construction to completion would be about three and a half years. This does not include the time needed to complete the engineering and prepare the contract plans or to administer the contract tender.

The main time elements of the work include these:

- Building demolition
- Utility relocation
- Drilling of east-side/center soil mix station walls
- Drilling of west side soil mix station walls
- Construct west side station decking
- Construct east side station decking
- Complete station excavation to full depth
- Bore tunnels and excavate south cavern
- Construct station box structure
- Demolish existing tunnels at station (Alternative 'A')



CONSTRUCTION SCHEDULE

FIGURE 13

30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

FOR STUDY PURPOSES ONLY

Fig-13.Dwg

FIGURE 13

- Backfill station box structure
- Rebuild/restore east side of Mission Street
- Rebuild/restore west side of Mission Street
- Construct tunnel south merge structures
- Complete station platforms and internal walls
- Install trackwork and BART electrical and utility systems
- Install station escalators and elevators and complete station finishes and furnishings
- Perform testing of station systems

Many of the above tasks can be implemented concurrently or are partially concurrent with each other.

The time during which the street traffic lane reductions would be imposed would be much less than the 42-months total construction time, lasting about 11 months at the onset and seven months at the conclusion.

High-Risk Construction Issues:

This project involves many unusual and difficult operations that entail risk. The meaning of risk is that there is a reasonable probability that unforeseen problems may arise or that foreseen problems might become more problematic than originally expected. Such factors include the possibility and increased potential for hazard during underground construction in constrained areas, and for construction near an operating rail system. Potential risk factors might include the following:

- Encountering undocumented underground obstructions
- Increased vulnerability to seismic events
- Possibility of groundwater intrusion and flooding
- Groundwater uplift and 'floating' upward of underground structures
- Need for additional soil improvement treatments along tunnels
- Damage to adjoining properties and/or properties above the tunnel excavations
- Need for special building underpinning
- Unforeseen subsidence and/or need for settlement monitoring and control
- Unforeseen noise and vibration mitigation
- Worker accidents
- Potential for accidents involving moving trains and their passengers

- Likelihood of repeated and/or severe service disruptions due to scheduling errors, failure to clear tracks, construction mishaps, etc.
- Consequential damages arising out of the above

To address these potential problems, all construction operations must be undertaken with utmost caution, with the most conservative safety measures fully enforced. In addition, costly special insurance policies might be warranted.

7. MAINTENANCE OF BART SERVICE DURING CONSTRUCTION

Service Reduction Windows During Construction

Track Availability for Construction: The present BART service schedule at the site operates passenger-carrying ('revenue') train service from 4:00 am until 1:30 am, five week days a week. Start-up on Saturdays is 5:30 am and 7:30 am on Sundays. Thus there is only a two and a half hour window most nights when revenue trains are not in running. However, during these intermissions, BART must still run occasional trains and equipment.

For example, during the night some BART trains are moved from place to place on the system to remove disabled trains from wayside sidings on their way to the repair shops. Also, trains may be moved from line terminal to terminal to 'balance' the correct number of vehicles and redeploy them for morning service start-up. The tracks are also used for routine and for unscheduled maintenance and to move maintenance equipment from place to place. Thus there is a constant demand for track usage even during the nighttime revenue service shutdowns.

When the tracks are removed from service for construction activities, it is necessary to shut off the electric traction power and also to deactivate the automatic train control facilities along the tracks. To assure safety, certain procedures must be followed and this requires a certain amount of time. Likewise at the conclusion of the construction activities, when the track is to be placed back into service, the safety procedures and tests needed are time-consuming.

Accordingly, useful construction windows cannot always be provided during regular nighttime service suspension. Instead, construction on the tracks must involve reductions in revenue train service. The opportunities for such service suspensions are those times when diminution of train service would inconvenience the fewest patrons. Such times are when trains run on longer headways and carry fewer passengers. This happens after 9:00 pm on weekdays and also on weekends, especially on Sundays.

It would be possible to provide seven-hour construction schedule windows between the hours of 9:00 pm and 4:00 am on each weeknight and also longer windows, from 9:00 pm Friday nights until 4:00 am Monday mornings. However, these construction opportunities would also be limited by the need for BART to use the tracks for purposes other than revenue service, as described previously. Also, there are certain times of the year and periods when special events would preclude any reductions in service.

Therefore, the available time for construction activities at the site is very limited.

Single Tracking:

It is not considered practical to completely shut down BART service even during the limited windows. Although it is possible in theory to set up substitute bus service ('bus-bridges'), there are serious deficiencies to that approach as will be described below. Therefore the option of single-tracking is the only remaining possibility. With single-tracking, one of the two BART

tracks is shut down for construction while trains from both directions take turns using the remaining track. This is feasible only during the times when fewer trains are running, as in the late evening and weekends. It nevertheless would impose considerable delay and inconvenience on patrons.

A single-tracking segment is defined by the location of existing crossover tracks. For the 30th Street Station site, the nearest crossovers are north of 24th Street Station and south of Balboa Park Station. Therefore, trains from north and south would take turns using one track between these points, running on one of the tracks through the Balboa Park, Glen Park and 24th Street Stations.

On Sundays, there are only two BART lines in service, each on a 20-minute headway (See Table in Section on Existing Conditions.) However, it is not feasible to operate all of the trains of both of these two lines over the single-track. Single-track operations entail train slow-down throughout the crossovers, waiting time and manual train control instead of computer automatic control. Single-track operations would be on 20-minute headways through the 24th Street to Balboa Park segment. Therefore, one of the two lines would have to be turned back at each end of this segment using the same crossover track locations.

Passengers on the turnback trains would have to be deboarded at 16th Street and Daly City Stations and wait for the following train. The wait time for these patrons until the next train would be 10 minutes.

It might be possible to supplement the single-track service with a bus-bridge or possibly with augmented parallel MUNI and/or Caltrain service. However, these are not sufficient to completely replace BART service. Substitute bus service was considered and described as follows:

'Bus-Bridge' Substitute Service Option

Substitute bus service during construction could take the form of a bus-bridge between BART 24th Street Station and San Francisco International Airport (SFO) and Millbrae/Caltrain. For this option, BART train service would be terminated at 24th Street Station. Service beyond that station (all the way to Millbrae and SFO) would be handled by the bus-bridge. This would be a difficult and costly operation because of the large number of buses involved and the volume of passengers having their travel times significantly increased (possibly an hour or longer from 24th Street to Millbrae).

The substitute service would start at 9:00 pm and continue until about 1:30 or 2:00 am for evening service suspensions. In order that morning service not be affected, the tracks would need to be returned to train use no later than 4:00 am weekdays, 5:30 am Saturdays and 7:30 am Sundays.

There are major disadvantages to this concept. Passengers from SFO or Millbrae/Caltrain might normally depart those BART stations on a last train at 11:50 pm. Such patrons could then get to

their destinations anywhere on the BART system. If a bus-bridge were used, the last bus would need to leave by about 10:30 pm or 11:00 pm in order to deliver passengers to 24th Street Station so as to catch the last trains to the Eastbay.

Thus there would be a great deficiency serving any passengers getting off work at 11:00 pm at SFO, and normally taking BART to get to Dublin/Pleasanton. These patrons would not be able to make the needed connections in time. The project would impose a heavy inconvenience on such passengers who may use the BART system between 11:00 pm and 12:00 am.

The bus bridge operation also would become more inconvenient for a greater number of customers on Friday and Saturday evenings when there is on average more late night patronage of the system.

8. OPERATIONS QUALITATIVE REVIEW

This is a initial qualitative analysis of the operational and capacity impacts of building an infill station at 30th Street. In addition, assessment of the delays to real-time train operations are more fully and accurately addressed in the simulation analysis described in the following Section..

As described above, the present study has narrowed various station alternatives to two, and these options are shown diagrammatically in Figure 14. There also continue to be slight variations possible for each alternative, such as the positioning of crossovers, etc.

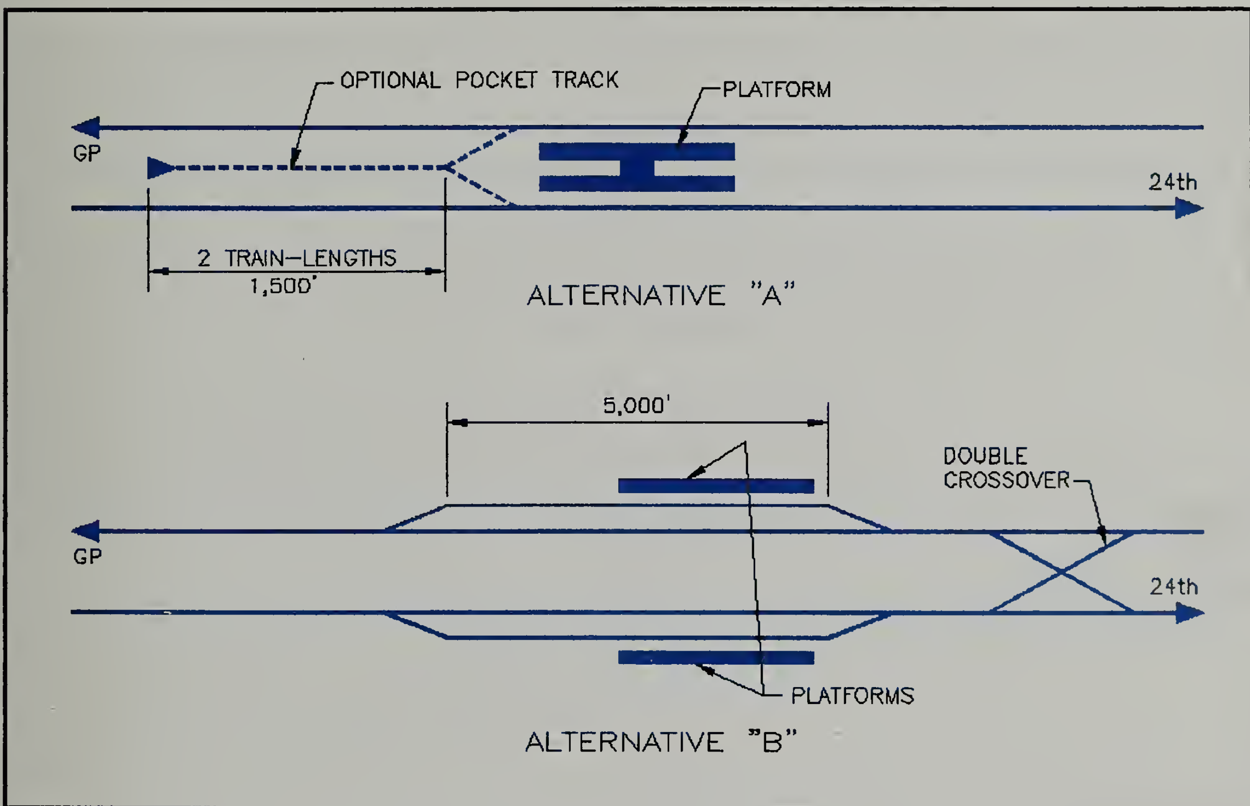


FIGURE 14

Alternative 'A': Two new tracks and platforms, with an option for a center pocket/tail track south of the proposed 30th Street Station. **This is an on-line station.**

Alternative 'B': Two new tracks and outboard platforms, located away from of the main line tracks, with a new crossover between the existing main tracks north of the proposed 30th Street Station. **This is an off-line station.**

Operating Assumptions

The BART staff has outlined the following potential operational assumptions as a basis for capacity analysis:

- A 12-minute base headway with two peak period rush trains (Pittsburg/Bay Point-Millbrae).
- Minimum two-minute headway during the peak hour on the main line.
- Optimize train sequencing
- Any scheduled short turnbacks at 30th Street Station would be by Fremont-to-30th Street trains. (The Fremont Line is also being considered for extension to San Jose/Santa Clara).
- Train sequencing and headways would be the same for both am and pm peak hours, in the peak direction.
- Full moving block automatic train control (AATC) operation on the main line.
- Alternatives must be capable of supporting through-train operations in both directions.

The following are the benefits and drawbacks of each Alternative:

Alternative 'A' – Benefits

- The basic scheme has no switching, thus there is no additional delay created by merging revenue trains.
- See below for benefits of turnback option.

Alternative 'A' – Drawbacks

- This scheme requires all trains to stop at 30th Street and so lengthens end-to-end runtimes for all routes. This might require additional revenue vehicles (a complete additional train for some routes) to maintain headways.
- All trains stopping at 30th Street would have to stop on a main line track, thus seriously reducing line capacity in both directions.

Alternative 'B' – Benefits

- Permits 'skip-stop' ('express') operation past 30th Street. Through 'express' trains would operate on mainline tracks while 'local' trains would diverge onto the side tracks to stop at the station platforms.
- Compared to Alternative 'A', this scheme provides a four-track segment with crossovers and off-line storage capability. This has improved potential for delay mitigation.

Alternative 'B' – Drawbacks

- With 'skip-stop' operation, there is a potential for very long station dwell during the peak period for those trains that serve the new 30th Street Station. During the peak hour, trains on the main line could run at minimum two-minute headway or less with AATC. Trains that stop at the platforms (probably the Richmond, Fremont and Dublin/Pleasanton Lines) may be held/delayed up to 12 minutes to wait for a gap in the bypass track schedule. (These trains could even be held until after the peak period, when train density is reduced significantly, to allow catch-ups in the schedule.) Thus in this example, only the Pittsburg trains, which bypass the station, would be exempt from excessive new delays.

  (There might be an exception to this if BART Central Control could direct occasional trains out-of-sequence by allowing the delayed stopped trains to 'force' a merge back onto the main line before the next scheduled bypass train arrives at the merge point. But this scenario might delay following through trains on the main line.)

- With very close headways and the potential train interactions that will be a result of a new AATC system, any delays or 'off-set' in timing for diverted trains to merge back onto main line, may result in reduced capacity. Delays or 'off-set' in timing for merging diverted trains onto the main line at 30th Street would also particularly reduce line capacity in the pm peak direction. This would occur for either 'skip-stop' or all trains stop at 30th Street, and delayed trains or running trains out of sequence from 30th Street to the north, would also unfavorably impact schedule adherence and on-time performance for all trains.

  The first late train of any delayed route arriving in downtown San Francisco would experience longer dwell time as more passengers accumulate on the platforms. Longer dwells will in turn exacerbate the delay and reduce train throughout at those critical downtown stations (Montgomery and Embarcadero), which control overall line capacity.

Alternative 'A' includes a turnback pocket track as an extra-cost Option. Alternative 'B' does not include a special turnback track, but would permit use of the two center bypass tracks for turnback as an operational option. If the center track were to be used for turnback/storage function, it could not be simultaneously available as a bypass/express track. There are also two types of turnback use – One for reversing revenue trains, and a second for storage and reversing of disabled trains. The following are the general benefits and drawbacks of turnback train operations:

Alternatives A' and 'B' Turnback Track – Benefits

- Operational flexibility by allowing revenue trains to turn back at 30th Street, out of the way of main line traffic. Potentially useful for future San Jose trains.
- Depending on the schedule, there may be the ability to reduce the need for rolling stock by saving a train on some routes, with short turnback of revenue trains at 30th Street instead of at Daly City or further south; OR:
- Capability to temporarily store disabled trains on the center track(s), out of the way of mainline traffic, facilitating delay recovery as well as reducing the impact of train mechanical failures.
- The tail track option of Alternative 'A' is on a flat grade, which improves safety and facility.

Alternatives 'A' and 'B' Turnback Track – Drawbacks

- Operational complexity requires merging of trains leaving the pocket track into the main line.
- For revenue turnback, trains would require three separate dwells: One for alighting passengers, a second on the turnback track to 'change ends', and a third for boarding passengers after the short-turn is completed. Changing ends would require train operators to walk through the train, from beginning to end, to 'key-in' and 'key-out'. This additional time could result in a missed schedule slot. (An alternative is to have two train operators, one at each end. But this would increase labor requirements and cost.)
- The three possible uses of the center tracks of Alternative 'B' – (express trains, revenue train turnback and disabled train storage) are mutually exclusive at the same time, yet they are all needed most at peak periods. It would be possible to augment the track layout to permit simultaneous uses, but only at additional cost.
- The 3.21 per cent grade of the center tracks in Alternative 'B' is disadvantageous for their most effective use for train turnback and storage. It is desirable for safety that these types of tracks be on flat grade. If not, special safety features might be needed at extra cost.
- Construction of the Alternative 'B' double crossover tacks on the existing mainline would disrupt train operations and require additional use of single-tracking and/or substitute bus service.

9. TRAIN OPERATIONS SIMULATION ANALYSIS

An analysis of train operations with and without a 30th Street Station was conducted by BART staff. A computer simulation was utilized based on certain operations assumptions which are listed below. The objective was to define train headways as the major index of system capacity and train 'thruput.'

Comparative alternative simulations were run for the existing line without the new station at 30th Street as well as with the new station. Also, there were alternative simulations run for train control based on the pre-existing train detection by track circuits (TC) so as to compare it with the new Advanced Automatic Train Control (AATC) system. Track circuits, which detect trains by electric current flow through the rails, are a traditional railway technology but have been a limiting factor in BART line capacity. The AATC improvements, which at completion for the entire BART system, will represents a total $100 million investment, is a new technology especially developed and implemented to improve BART system capacity, especially the train capacity of the Transbay Tube.

Advanced Automatic Train Control (AATC)

The BART system already handles 90 million passenger journeys a year, and in the mid-1990s projections for traffic growth suggested that BART urgently needed to increase line capacity. Critical points on the network are the Oakland Wye junction and the Transbay Tube. Building new lines under the Bay would cost many billions of dollars, and the search for a more cost effective alternative to permit shorter headways on the existing system pointed to improving the control exercised upon every train on the network.

Therefore, BART and its contractors begin developing AATC in 1994. The new AATC system will cut headways and shorten end-to-end journey times, improving the ability to recover after delays and allow BART to run its existing service with one fewer trainset. Also, with fewer brake-to-power transitions, energy consumption will be reduced.

Operating Issues and Concerns:

- Reliability and travel times from station area to Downtown, Peninsula and Eastbay
- Travel time would increase between stations south and north of 30th Street
- New station would affect operating capacity on BART lines and rider capacity on trains, especially morning peak northbound trains

The backbone of AATC is a robust radio network providing data communication and radio-ranging determination of train location. The AATC system communicates vital location data using a radio network rather than inductive wire loops, or track circuits, both of which are more traditional methods of train detection.

(The above description was partially excerpted from *Railway Gazette International*, as reproduced in Appendix I)

The following are the assumptions used in conducting the headway simulation of the present study:

Track Circuit (TC) System Simulation Assumptions

- All 10-car trains
- Maximum train speed of 70 miles per hour (BART designation of 'PL2')
- Station dwell times of 30 seconds
- Simulations did not include turnback times at end of line
- Spacing between trains of 700 feet minimum (as per Sequenced Occupancy Release System enabled - SORS is a safety system that assures a minimum distance between trains)
- All existing track speed limits enforced
- Station Target Velocity of 36 miles per hour. (Station Target Velocity is the top speed at which the front of the train first may enter a station. Under track circuit control this is 36 miles per hour, that being the closest track circuit speed code available.)

Advanced Automatic Train Control (AATC) System Simulation Assumptions

- All 10-car trains
- Maximum train speed of 70 miles per hour (BART designation of 'PL2')
- Station dwell times of 30 seconds
- Simulation did not include turnback times at end of line
- Minimum spacing between trains of 700 feet not enforced
- Speed limit defined by maximum track design speed (about 80 mph)
- Station Target Velocity of 43 miles per hour. (Station Target Velocity is the top speed at which the front of the train may first enter a station. Since AATC can send any speed code in one mph increments, it can more closely match the optimum station-stop target speed, than has been possible with track circuits.)

Simulation Results

This simulation analysis addresses only the Alternative 'A' basic on-line station for which all trains would have to stop. The operational affects of the Alternative 'B' off-line station would presumably be less pronounced because not all trains would stop at 30th Street. However, its overall analysis would be much more complex. The operational scenarios of Alternative 'B', and their advantages and disadvantages have been described qualitatively in the previous Section.

The results of the simulation are included in the tables below as train headways in seconds at various stations along the line. Each of the train control alternatives is shown with respect to the following operating scenarios, or *'crush'* definitions:

'Uniterfered Crush': This criterion is utilized for analysis of scheduled train service. This is the minimum scheduled headway resulting when all following trains run end-to-end as though there were no other trains on the track (i.e. - as fast as the lead train). Resulting train headways are as follows:

	UNINTERFERED CRUSH HEADWAYS	
	Track Circuit (TC) Control	**AATC**
EXISTING SYSTEM:		
Westbound/Southbound Track	130.5 sec @ Daly City	**128.0 sec @ Daly City**
Eastbound/Northbound Track	142.5 sec @ Balboa Park	**123.0 sec @ Balboa Park**
WITH 30TH ST. STATION:		
Westbound/Southbound Track	130.5 sec @ Daly City	**129.5 sec @ Daly City**
Eastbound/Northbound Track	191.0 sec @ 30th Street	**171.5 sec @ 30th Street**

Accordingly, there are increases in headways projected for the San Francisco BART line with the introduction of a 30th Street Station. An increase in headways means that passengers must wait longer for trains; therefore this is a degradation in service. The results for AATC are the significant values as this is the control system that is now being placed into service. The table illustrates that the AATC system enables reduction in headways from the pre-existing TC system. The results also show that the more significant headway increases are for the eastbound/ northbound track

Comparing the 123.0 vs 171.5-second values in the above table indicates that the eastbound/northbound headway increase would be 48.5 seconds, or a degradation of about 39 percent.

'Recovery Crush': This criterion is utilized to define headways needed to recover from service interruptions or delays. Under this criterion, two trains are dispatched 60 seconds apart. The lead train is held at each station platform until the following train is forced to come to a complete stop behind it. The Recovery Crush Headway is measured as the longest time between train departures from amongst all the stations in the simulated segment. The resulting headways are as follows:

	RECOVERY CRUSH HEADWAYS	
	Track Circuit (TC) Control	**AATC**
EXISTING SYSTEM:		
Westbound/Southbound Track	116.0 sec @ Embarcadero	**87.5 sec @ Daly City**
Eastbound/Northbound Track	110.5 sec @ 24th Street	**83.0 sec @ Daly City**
WITH 30TH ST. STATION:		
Westbound/Southbound Track	116.0 sec @ Embarcadero	**87.5 sec @ Daly City**
Eastbound/Northbound Track	143.5 sec @ 30th Street	**124.0 sec @ 30th Street**

The above table shows that there is an even more pronounced improvement from TC to the new AATC control. However, the most significant finding is that there is a substantial degradation of

about 49 per cent in headways from 83.0 to 124.0 seconds eastbound/northbound with introduction of a 30th Street Station. However, no degradation is indicated westbound/ southbound.

'Steady State Crush': This is a theoretical index also used to analyze train headways. For this index, thirty trains are dispatched 60 seconds apart. The Steady State Crush headway is the average time between departures at the last simulated station for the last three trains in the simulation.

	STEADY STATE CRUSH HEADWAYS	
	Track Circuit (TC) Control	**AATC**
EXISTING SYSTEM:		
Westbound/Southbound Track	111.5 sec	**89.5 sec**
Eastbound/Northbound Track	114.5 sec	**87.0 sec**
WITH 30TH ST. STATION:		
Westbound/Southbound Track	113.0 sec	**90.0 sec**
Eastbound/Northbound Track	147.0 sec	**125.0 sec**

Again, there is a decrease in headways with AATC, but an increase in headways with a 30th Street Station.

Run Times: These are calculated for the travel time between Embarcadero Station to Daly City.

	RUN TIMES	
	Track Circuit (TC) Control	**AATC**
EXISTING SYSTEM:		
Westbound/Southbound Track	25 min 25.0 sec	**23 min 40.5 sec**
Eastbound/Northbound Track	25 min 62.5 sec	**24 min 34.0 sec**
WITH 30TH ST. STATION:		
Westbound/Southbound Track	26 min 33.5 sec	**24 min 36.0 sec**
Eastbound/Northbound Track	27 min 3.5 sec	**25 min 32.5 sec**

For the existing system without the new station, the AATC System reduces run times in all cases, with a one-minute, 28.5 second improvement on the eastbound/northbound track. However, with the 30th Street Station added, the run times are increased in both directions, up to 58.5 seconds on the eastbound/northbound track.

In addition to the above quantitative headway simulation, BART staff previously undertook a separate study based on estimating existing available excess line capacity and the potential impacts resulting from a 30th Street Station. That analysis is described in the following section.

Conclusions Regarding the Simulated Operations Analysis

The simulation analysis was conducted in terms of train headways, which are the time intervals between trains as indicated at various station locations along the San Francisco line. The capacity of a line is inversely proportional to train headways. That is, as the time between trains increases, the number of trains and hence line capacity decreases, and service is therefore degraded.

Line capacity can be also increased by adding cars to each train or adding passenger capacity (i.e. removing seats and increasing standee space) in each car. However, BART trains already operate at the maximum length of 10 cars through the Transbay Tube during peak periods. Removing seats from the trains would not likely be regarded as a popular or easily implemented policy.

There would clearly be a degradation of BART line-haul service if a 30th Street Station were implemented. The most important impact on AATC capacity with the 30th Street Station is on the eastbound/northbound track (from Daly City/Colma to the Eastbay). To a large degree, this is caused by the downgrade of the track in the area of the new station, which increases the stopping distance of the trains going toward downtown.

Similarly with regard to headway, the 30th Street Station would have the major impact in the eastbound/northbound direction, as it becomes the 'worst' station on the line in terms of its affect on train headways. However, westbound/southbound trains (from Eastbay to Daly City/Colma) are virtually unaffected by the 30th Street Station. This is because in that direction, there are other stations on the line with more detrimental effects on headways than the proposed 30th Street Station. With regard to run times, 30th Street Station impacts the system unfavorably, but about equally in both directions.

In summary, the simulation shows that the magnitude of the degradation would be a major setback to the improvement in line capacity achieved by implementation of the new AATC system. However, there are various ways to interpret this potential change:

The most optimistic conclusion would be that the AATC system will make possible the addition of a 30th Street Station without a degradation of BART line capacity below that which existed previously with the track circuit train detection system. Under this interpretation, however, part of the cost of AATC on the San Francisco line should be assigned to the 30th Street Station in comparing the project costs to its benefits.

A more pessimistic interpretation of the simulation findings is that the addition of a 30th Street Station would set back BART operations to a condition similar to that which prevailed before AATC. If conditions were considered unsatisfactory then, a return to a similar condition in the future might be regarded as even more unsatisfactory.

As described in previous Sections, the Alternative 'B' off-line station might permit some mitigation of the elongated headways calculated for through-trains by the simulation, but at the price of lesser service to the 30th Street Station itself.

While the projected increases in travel times of slightly less than a minute may seem minor, any increase in rail system travel time is potentially very significant. When train run time is increased, a larger number of trains is required in order to support a given passenger capacity. For an increase of the indicated magnitude of the simulation an approximate increase of one train set of 10-cars would be needed. The equivalent capital costs, based upon $3 million per rail car, would thus be about $30 million. In addition, there would also be increased maintenance costs for the extra cars, more repair shop space needed, etc. None of these costs have been included in the preliminary cost estimate conclusions of this report.

10. SYSTEM CAPACITY

Line Capacity Factors

A line capacity analysis was conducted to assess the impacts on Transbay capacity of adding an infill station. The analysis focused on estimating the available line capacity sufficient to meet Transbay demand during am and pm peak hour, peak direction as this is the period which rolling stock and resources are taxed to the maximum.

The analysis approached the problem by determining the magnitude of excess capacity, if any, of the Transbay line. It was then assumed that any such excess capacity would be available to serve the needed extra service demand of a new 30th Street Station. A further assumption of the analysis is that all available trains would be dispatched to support the peak demand.

AM Peak Hour

The results reveal that there is sufficient am peak hour westbound line capacity to accommodate new riders from downtown San Francisco to points west and south. Since the majority of passengers deboard as one of the four downtown stations, westbound trains would not be crowded after leaving downtown. However, lacking any ridership estimates of westbound Transbay traffic due to a 30th Street Station, it is difficult to analyze if new trips of significant numbers might be generated that would impact westbound Transbay capacity.

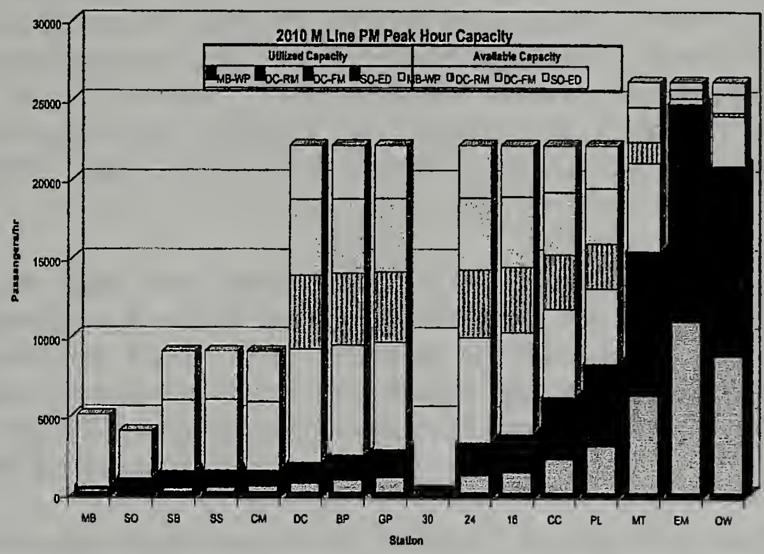
It should be noted that am peak hour Transbay capacity is estimated to reach headway limits at around FY2012, with 28 trains per hour in the peak direction. Judging by the number of trips generated at 24th and Glen Park Stations (only 478 am peak hour trips from the Eastbay in FY2010), it is postulated that new ridership generated by a 30th Street Station from the Eastbay is likely to be small.

The am peak hour eastbound trains carrying passengers from southern points to downtown San Francisco may experience capacity constraints between 24th Street and 16th Street Stations. Some lines may be more crowded than others. Since all four routes utilize the main line in the eastbound direction, proper load management can effectively spread demand amongst these lines. Furthermore, since high-load eastbound trips are relatively short (only a few stations to downtown), passengers might be willing to tolerate more crowded trains in that short segment than for a longer trip all the way to the Eastbay.

PM Peak Hour

Variability in headway as a result of extended dwells and close station distance spacing (especially as occurs in downtown San Francisco) has been found to significantly reduce line throughput in the pm peak hour. The results shown in the bar diagrams 15-A and 15-B indicate that there is approximately 1,380 available Transbay trip capacity for FY2010 and FY2020.

FIGURE 15-A
FY2010

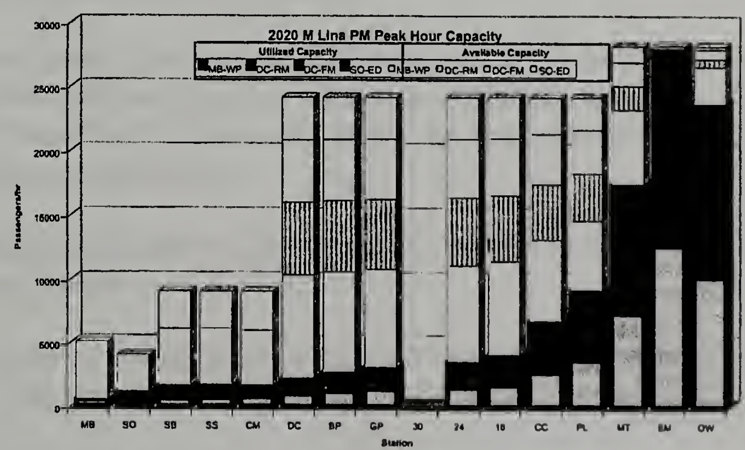


Available pm peak hour transbay capacity (passengers/hr):

Year	FY2010	FY2020	
		Unconstrained	Constrained
Available Capacity	1,382	2,138	125

Although Figure 15-B shows significant eastbound capacity for FY2020 that is available west of the major downtown stations, this capacity is needed to satisfy Transbay demand and, therefore, should be reserved to meet the greatest demand at the *maximum load point station,* which is Embarcadero. Thus, eastbound Transbay traffic generated by the 30th Street Station, while assumed to be low, would have detrimental impact on line capacity to the Eastbay, if it were to exceed the available Transbay capacity.

FIGURE 15-B
FY2020



Line capacity was also estimated for FY2020. The unconstrained analysis assumed that the train control system will be sufficient to handle the required train density to meet rising demand. It also was assumed that service levels would not be reduced significantly from current levels, thus maintaining a similar level of service. The constrained scenario assumes a maximum train throughput of 28 trains per hour, which is the maximum throughput possible with the implementation of AATC. This includes an acceptable operating margin to account for delay recovery.

The results indicated that there were approximately 2,140 and 125 available pm peak hour Transbay capacity (passengers per hour) for the unconstrained and the constrained scenarios, respectively for FY 2020 (see Figure 15A). Since rising ridership would require BART to increase service, the service planning model also showed that by FY2020, the unconstrained scenario would require BART to acquire approximately 70 new cars to operate the service plan, with 49 new cars needed for the constrained scenario.

Figure 12-B presents the constrained scenario for FY2020. It shows that eastbound pm peak hour Transbay capacity demand is at its maximum at Embarcadero Station. Any additional trips generated by a 30th Street Station, or any other infill station on the line will be a detriment to that line capacity.

Summary of Findings on Operations

1. Alternative 'B' offers superior operational flexibility and means to recover from delay. It is preferred to all the other alternatives studied, especially for the critical eastbound pm peak.

2. Alternative 'A' is not as operationally beneficial as Alternative 'B' but nevertheless appears to be minimally acceptable from the operations standpoint, subject to further more detailed analysis.

3. With either of the two Alternatives, there will probably be sufficient am peak hour capacity in the westbound direction to satisfy demand.

4. A 30th Street Station (with either Alternative) may contribute to limited capacity constraints at 24th and 16th Street Stations in the am peak hour, eastbound direction. However, since the trips are short and better load management across the lines may mitigate these effects, this is not now considered a serious impact.

5. New eastbound traffic generated at a 30th Street Station would limit the critical pm peak hour eastbound Transbay capacity by FY2020.

6. A detailed assessment of the impacts of delays to real-time operations can be determined only after detailed line simulations of the proposed Alternatives are undertaken.

7. The provision of turnback capabilities would be beneficial, however, similar capabilities might be provided elsewhere at lower cost.

11. RIDERSHIP

Station Patronage

The only available projections of station patronage were developed in a brief study which was prepared by the San Francisco County Transportation Authority in 1998. However, that study as excerpted below lacked detailed origin/destination input data, and was based only upon demographics.

Comparative Demographics

The population within a one-quarter mile radius of 30th and Mission Street is nearly 20,000. This is equivalent to a density of about 40 persons per acre. By comparison, the population within a one-half mile radius of the BART 24th Street Station is about 35,000, with a density of 65 persons per acre. Therefore the density at 30th Street is about three-fifths that of 24th Street.

Zero-vehicle households constitute 11.7 percent of the population near the 24th Street Station, but only 8.5 percent of the population near the proposed 30th Street Station. The poverty rate is similarly higher for 24th Street compared to the 30th Street location. Those who live near 24th Street Station undertake about 25.5 percent of their trips by transit, while those near the proposed 30th Street Station make only 18.5 percent of their trips by transit. The residents of 24th Street make 53 percent of their trips to downtown San Francisco by transit, while 30th Street residents make 48 percent of their trips to downtown by transit.

Current Ridership Levels

Current ridership at the 24th Street BART Station is 9,500 weekday exits. This is one of the highest ridership stations – on the order of Berkeley, 12th Street Downtown Oakland, and Balboa Park (which has parking and better transit service) Stations. The ridership at the Glen Park Station is 6,300 weekday exits.

BART Ridership Factors for Proposed 30th Street Station

- It should be noted that ridership numbers are difficult to estimate accurately without specific origin/destination numbers.
- Using demographic information only, from the areas around the 24th and 30th Street Stations, ridership levels of the proposed 30th Street Station would probably be no higher than 60 percent of the level of the 24th Street Station. This ranges up to a maximum of 5,700 expected riders. However, it is likely that this number would actually be lower because the residents around the 24th Street Station are more likely to be of lower income levels (and therefore more transit dependent) than those near the proposed 30th Street Station. Because of this, the numbers might be only two-thirds to three-quarters of the 5,700 patronage at 24th Street, or on the order of 3,800 to 4,300 riders. The ridership numbers might be further diminished because of the proximity of the 24th Street Station. On the other hand, patronage

might be subject to increase because the 14-Mission, 24-Divisadero, and J-Church MUNI lines could function as feeder routes to the proposed station.

- The 24th Street BART Station ridership might also be subject to decrease because some patrons who currently ride the 14-Mission or 67-Bernal Heights buses would disembark at 30th Street instead of 24th Street. The number of patrons who access the 24th Street Station by foot would probably also decline, as some would find the new 30th Street Station more convenient.
- Glen Park BART Station ridership might decline somewhat, but probably not to the extent as at 24th Street. This is because 30th Street is closer to 24th Street than to Glen Park, and there is hilly topography, which impedes pedestrian travel between Glen Park and 30th Street.
- Ridership could also possibly attract current automobile users who do not use MUNI to transfer to BART, and also possibly residents of new dwellings development that might be spurred by the new BART station. Thus it is possible that the percentage of persons in this area who commute to downtown by transit would increase by up to 10 percent with a mode split similar to the 24th Street area. This could mean that up to 500 riders of the proposed station just to the downtown area, would be new BART riders.

Based on all the above factors taken together, a value of 3,700 to 5,000 riders might be expected to use a 30th Mission Street Station.

Anticipated New Factors

The above 1998 ridership projections by the San Francisco County Transportation Authority did not anticipate the opening of the BART extension south of Colma and did not include riders using BART to reach San Francisco International Airport, or Millbrae and the Caltrain connection to points along the Peninsula and to Silicon Valley.

In addition, land use changes since that time and as proposed for the future by the City of San Francisco also need to be assessed to estimate the full ridership potential of the new station with any degree of accuracy.

Ridership Considerations:

- 1998 San Francisco County Transportation Authority ridership projection: 3,800 – 5,700
- Caltrain connection at Millbrae could add many new riders to BART
- Riders expected to be diverted to BART from Mission MUNI lines
- Station could attract new riders to other MUNI connecting lines

Currently, the San Francisco Planning Department and various neighborhood groups are planning to revisit zoning, land use and housing changes in the immediate vicinity of 30th and Mission. At the same time, relevant changes are also being proposed for key MUNI transit corridors that link to the 30th and Mission site, particularly along the eastern Bayshore and within the vicinity of Bernal Heights. The outcome of these efforts would be essential in establishing the full magnitude of ridership and benefits that this station could attract, generate and create.

12. INTERMODAL CONSIDERATIONS

BART/MUNI Transfer

The transfer potential between BART and MUNI at a new 30th Street Station would generally be the same for any of the described alternative BART stations and track layouts. Transfer of passengers would be via escalator or elevator to the surface street, where MUNI bus routes load at on-street stops. The service impact of a new BART station would generally occur in one of four ways relating to the existing MUNI routes:

1.a. Those MUNI routes that run approximately parallel to the BART line, and that already serve other existing BART stations, would be expected to lose a very small amount of patronage to BART. These routes include the 14-Mission, 14L-Mission Limited, 26-Valencia, 49-Van Ness/Mission and J-Church light rail. The presence of a BART station at 30th Street would encourage BART passengers with origins or destinations near there, and who presently transfer to any of the above MUNI routes, to consider a transfer to MUNI at 30th Street instead of their present transfer station. Or some of these passengers may be able to completely substitute a BART-only trip instead of their present MUNI/BART combined trip. In either of these cases, the MUNI ridership would be reduced, but probably by only a very small volume. It would be expected that, given the opportunity, passengers with an option would choose to use BART, (assuming equal fare cost) because it is faster than MUNI.

b. It is also possible, however, that the above MUNI parallel routes might regain an even slighter patronage due to the improved BART access at 30th Street. This would be due to the improved SFO Airport and Caltran connections. Thus the parallel MUNI routes would be acting in this role as collector/distributors for BART access. However, the net affect on the parallel MUNI routes can still be expected to be small.

2. For a crosstown MUNI route such as the 24-Divisadero, which presently does not serve any BART station and does not generally parallel BART, it would be expected that related transfer ridership would increase on both MUNI and BART. This is because the opportunity and convenience of transfer would increase the overall performance of transit and therefore draw new riders. Indeed, a transfer between BART and the 24-Divisadero would be the greatest single intermodal improvement of the proposed project. This is due to the large service area of the 24 Line, which extends all the way from the Marina District to Hunter's Point. However, the Hunter's Point connection would be the most significant because all the other northerly neighborhoods along the 24 Line already have more direct MUNI routes to existing BART stations.

3. For a local shuttle route such as the 67-Bernal Heights line, which already serves another BART station at 24th Street, it would be unlikely that a new 30th Street Station would have great impact on ridership. There would be a slight improvement in travel time for transferring passengers using the new station, for whom the bus journey would be shortened.

For those patrons who would be able to substitute BART instead of MUNI for all or part of their journey, comfort, reliability and speed would be improved and crowding conditions reduced.

Parking

The objectives of this project do not include provision of BART station parking. This is in keeping with present BART and City of San Francisco policy, as BART parking in any other San Francisco is limited to a small number of spaces at Glen Park Station. Parking impacts of a new station would be limited to that resulting from surface street modifications needed to construct the new station. These would include possible elimination of some on-street and off-street parking during construction.

But in addition, there is also the potential to improve or increase neighborhood parking as a component of, or a byproduct of the station project. Such improvements could range from merely widening of the existing narrow on-street parking lanes, up to a major increase in parking supply by construction of one or more additional neighborhood off-street parking lots. Such new lots could utilize any surface right-of-way that might be obtained for the project and that became surplus at its completion.

Conversely, if the objective is to strictly limit right-of-way obtained for the station project there may be no excess right-of-way, and it might be necessary to reduce the present parking slightly in order to obtain space for the station entrances or for MUNI bus stops. For example, the large Safeway parking lot on the west side of Mission Street may be encroached upon by construction and also might be considered as the location for future station entrances. Likewise, the Pizza Hut property on the east side of Mission Street, including its parking lot, could be considered as the location of a major station entrance incorporated into a joint development.

Handicapped Access

With respect to ADA and handicapped patron transfer to MUNI at a new 30th Street BART Station, it is expected that few special facilities would be needed on the surface of Mission Street. The gradient of Mission Street at the proposed station location is approximately three per cent, which is well within the five per cent maximum slope required by ADA for pathways and ramps.

Transfer to the nearest ADA-accessible MUNI Metro J-Line stop at San Jose Avenue is approximately 1,400 feet from the proposed 30th Street Station location, and this appears impractical for a direct transfer or connecting pathway arrangement. This transit connection might be regarded as a redundant route option, because BART-to-J-Line transfer is available at other existing BART stations. However, the transfers at Glen Park and Balboa Park Stations are circuitous and not handicapped-friendly due to grade changes or length. The transfer at Civic Center Station is distant from the proposed station site. Thus the J-line transfer at a new 30th Street Station could be a net improvement to connect and integrate BART and MUNI Metro, especially for the handicapped.

Station entrances located along Mission Street and/or on cross streets may be placed in newly constructed sidewalk bulb-outs to avoid blockage of the existing sidewalks. Taxis serving the station could use MUNI bus stops adjacent to the proposed station entrances in a similar fashion as at the 16th and 24th Street Stations.

A possible design refinement would offset the station position toward the west to preserve the east property line, but this would sacrifice more of the property frontage along the west side of Mission Street. Consequentially, post-project redevelopment of these west-side properties at the station site might provide additional area for more off-street space for new bus/taxi pullouts.

13. COST ESTIMATES

Basis of the Estimates

All unit costs in the estimates are representative of contractor bid prices at first quarter of 2002 pricing levels. Unit rates in the estimates include contractor indirect costs, mark-up and profit.

BART General Conditions: A five per cent allowance of construction costs has been utilized to cover the following types of items:

1. Differing site conditions
2. Partnering
3. Dispute resolution
4. Operating system access delays
5. Construction safety incentives / disincentives
6. Engineer's office, vehicles and services
7. Operation and maintenance instructions and personnel training

City Imposed Conditions: A 10 per cent allowance of construction costs has been included in the estimate to cover costs for traffic and MUNI re-routing and restoration costs, and street and limited neighborhood upgrades after construction.

Contingencies: A 25 per cent contingency allowance is included in the estimate. This contingency covers design, scope, construction estimating and pricing contingency up to project completion.

'Soft Costs': The following line item costs have been included as percentages of the total construction costs:

1.	Pre-project / Environmental studies	3 per cent
2.	Preliminary Engineering	4 per cent
3.	Agency administration	5 per cent
4.	Community outreach	1 per cent
5.	Professional services (Engineering, Project Management, & Construction Management	30 per cent
6.	Pre-operating expenses (Start-up and Testing)	2 per cent

Construction Cost Summary

	Alternative 'A' On-Line Station *Basic*	Alternative 'A' *with Pocket Track*	Alternative 'B' Off-Line Station
Construction Elements	$227,183,000	$247,346,000	$235,768.000
Mobilization @ 10%	22,718,000	24,735,000	23,577,000
BART General Conditions @ 5%	11,359,000	12,367,000	11,788,000
City Imposed Conditions @ 10%	22,718,000	24,735,000	23,577,000
Subtotal Construction Cost:	**$261,261,000**	**$309,183,000**	**$271,133,000**
Contingencies @ 25%	65,315,000	77,296,000	67,783,000
Administration, Engineering and Operations ('Soft Costs')	117,567,000	139,132,000	122,010,000
TOTAL Project Facilities Construction:	**$444,143,000**	**$525,611,000**	**$460,926,000**

See Appendix 'J' for itemized cost listing and the full assumptions utilized for these estimates.

Exclusions

The following costs are not included in the estimate:

1. Right-of-way and other property acquisition, easements and encroachments
2. Community mitigation costs
3. Escalation beyond first quarter of 2002
4. Schedule impact
5. Environmental mitigation and hazardous works
6. Project insurance
7. Financing and interest during construction
8. Increase in vehicle fleet size associated with operations through the station
9. Costs of modifying BART central control
10. Costs of substitute transit service during construction
11. Multilingual publicity and information programs during construction

What Are Other Projects Going to Cost?

Selected Bay Area Rail Capital Projects (in millions)

• Caltrain Extension/Transbay Terminal	$1,885
• MUNI Central Subway	$647
• BART to Warm Springs	$634
χ BART 30th Street Station	$445-525
• BART Oakland Airport Connector	$232

Source: Metropolitan Transportation Commission

14. CONCLUSIONS AND NEXT STEPS

Conclusions

This study concludes with the following findings:

- The three evaluated Alternatives are each basically feasible
- All the Alternatives are very costly projects
- The defining track gradient limitation of one percent (compared to the existing grade of 3.12 percent) is a major influencing factor that drives up the cost for a project of this type
- The Alternative 'A' basic scheme is least costly
- The Alternative 'A' scheme with a Pocket Track Option is most expensive
- Alternative 'B' includes the most important benefits and is only marginally more expensive than the lesser-cost Alternative 'A'
- This would be a very difficult and risky project to construct
- Property and business disruption impacts would be substantial
- Constriction traffic impacts would be significant, but subject to mitigation
- Local access to regional transit via BART at 30th Street would be greatly improved
- Ridership potential has been estimated at 3,700 to 5,000 riders, but new factors could result in more users. Therefore, an updated, more comprehensive and detailed projection is needed.
- Alternative 'B' offers superior operational flexibility and means to recover from delay. It is preferred to the other Alternatives, especially for the critical eastbound pm peak
- Alternative 'A' is not as operationally beneficial as Alternative 'B' but nevertheless appears to be minimally acceptable from the operations standpoint
- A 30th Street Station (with either Alternative) may contribute to limited capacity constraints at 24th and 16th Street Stations in the am peak hour, eastbound direction
- With Alternative 'A' train headways would be increased by up to 49 per cent with corresponding reduction in line capacity

Impacts:

- Construction:
  - Noise
  - Transportation disruptions (MUNI, traffic & BART)
  - Night work
- Long term:
  - Transbay capacity
  - Changes on traffic patterns & volumes
- Risk:
  - Major service disruptions
  - Construction hazards
  - Insurance

- With either of the two Alternatives, there will probably be sufficient am peak hour capacity in the southbound/westbound direction to satisfy demand
- New northbound/eastbound traffic generated at a 30th Street Station would limit the critical pm peak hour eastbound Transbay capacity by FY2020
- Operational benefits of a turnback can be provided, however, such capabilities are being reviewed on a systemwide basis and might be provided elsewhere at lower cost
- Improvements to MUNI transfer and local transit would be minimal because most MUNI lines in the vicinity already interface with BART elsewhere
- The 24-Divisadero MUNI line would benefit the most by having a 30th Street BART connection
- Transit choices and handicapped access would be improved
- The potential for neighborhood beneficial improvements might be substantial, but its description and analysis was outside the scope of this study
- The potential for joint development would be potentially important but its description and analysis was outside the scope of this study

Next Steps

If this project is to proceed, certain steps would need to be undertaken. First of all, this report should be circulated and reviewed by those who have an interest in the project.

A community planning effort may be warranted if the City and County of San Francisco chooses to take (and sponsor) any next steps. A project manager may be selected to lead efforts. Also, there is the possibility to appoint one or more standing committees to oversee the project. These might include a governing board of elected officials, and/or a citizens advisory committee and a technical advisory committee of professional planners, engineers, architects or officials.

What Happens Next?

- Community feedback & acceptance of report
- Possible Community Planning effort
- Involve collaboration of BART & City of San Francisco Agencies (MUNI, DPT, Planning, Transportation Authority)

Ongoing lines of community-based communication and review would need to be established by the sponsoring agency with BART, MTC, and City departments such as MUNI, City Public Works Department and the Transportation Authority.

A further technical development process would need to be defined and pursued. At the same time, a community and policy-making consensus might be encouraged through a process of outreach, involvement and discussion. Additional technical and economic studies would need to be undertaken, possibly including, but not limited to the following:

- Update ridership projections. Improved transit ridership estimates would be critical to evaluating the value of this project, and the presently available ridership projections have not been updated beyond the 1998 rough estimates by the San Francisco County Transportation Authority.

  Those estimates did not have adequate origin/destination data and did not anticipate several very important factors, such as the SFO Airport connection, that have materialized since then. In addition, land use changes since that time and as proposed by the City would have to be assessed to estimate ridership potential with any degree of accuracy.

  The outcome of an effort to fully quantify these factors would be essential in establishing the magnitude of ridership that this station could attract and generate.
- Continued definition and ranking of all the available alternatives.
- More detailed operational evaluations, especially of the more complex modes of use of the off-line station (Alternative 'B') option.
- Focused studies for various engineering elements, especially tunneling and geotechnical aspects.
- Detailing of station configuration and property requirements.
- Preparation of more detailed and accurate capital and operating cost estimates and value engineering studies.
- Possible companion studies to address with specificity, potential neighborhood improvement projects and joint development opportunities, including transit oriented development and 'transit village' sites. The latter would be important as an impetus to increase the benefits to be expected from the project and for 'value capture'.
- More wide-ranging cost/benefit evaluations so as to establish the project as eligible to meet the BART system expansion criteria and also to qualify for outside funding sources.

APPENDICES

APPENDIX A

Bay Area Rapid Transit District

POLICY AND CRITERIA FOR SYSTEM EXPANSION

System Expansion Criteria and Process

Adopted by BART Board - 12.5.02

System Expansion Policy

Introduction

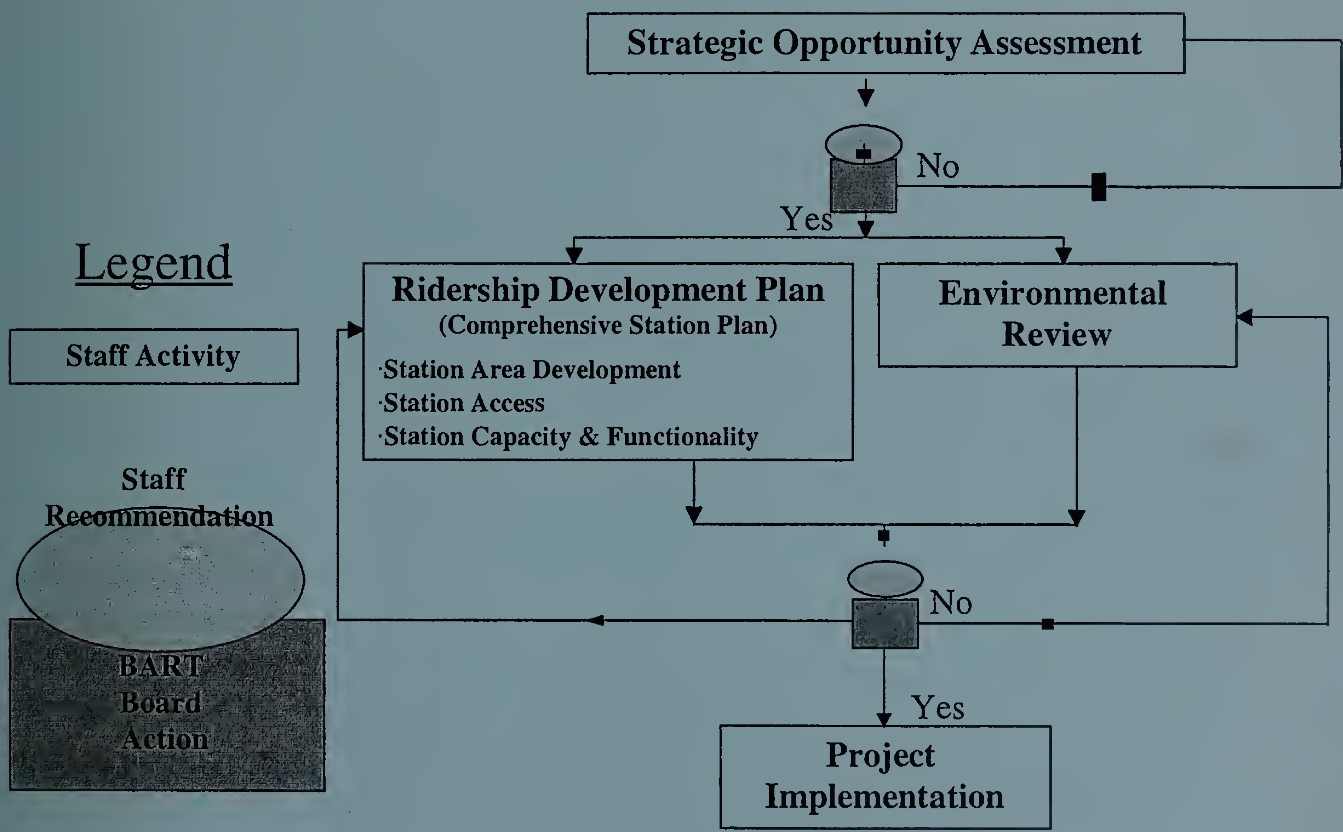
Over forty years ago, residents of the Alameda, Contra Costa and San Francisco Counties supported the creation of the BART District. Since that time, BART has become a critical component of the region's transportation system.

Today the pressures of growth in the Bay Area continue. Accommodating this growth continues to drive further dispersal of jobs and housing. At the same time, BART and other transit systems demand a continued level of reinvestment to maintain service. Finally, financial support for BART and other transportation systems must compete with their infrastructure and social needs. It is imperative that BART, as a steward of public funding for transportation investments, continue to:

·Ensure cost-effective transportation investment decisions;
·Protect the taxpayers' investment in the District's physical infrastructure;
·Ensure the financial health and sustainability of the District; and
·Enhance the Bay Area's environment and quality of life.

It is with these considerations that the BART Board adopts the following Project Advancement Criteria and Process for all System Expansion projects.

Project Advancement Process



Project Advancement Process

Stage 1

- **Strategic Opportunity Assessment**
  - Initial planning assessment of transit expansion opportunities
  - Level of effort commensurate with funding availability for study
  - May include several planning efforts before project recommendation brought forward to the Board

- **Project Advancement**
  - Staff uses study reports to evaluate a project against the criteria and decides whether to recommend a project for advancement to the next stage
  - Board considers staff recommendations and decides whether to advance project recommendation to the next stage for further study

Stage 2

- **Ridership Development Plan**
  - Work in partnership with local jurisdictions to develop a Memorandum of Understanding (MOU) laying out coordinated timelines for transit project Environmental Review and the Ridership Development Plan process
  - Work in partnership with local jurisdictions to achieve transit ridership thresholds by balancing transit-oriented development (TOD) and access goals with community desire; seek commitments from local jurisdictions regarding land use and access plans

- **Environmental Review**
  - CEQA and/or NEPA environmental review process (as applicable).

- **Project Advancement**
  - Ridership Development Plan prepared concurrently with Environmental Review and brought forward to the Board
  - Staff uses both documents to evaluate project with the criteria and decides whether to recommend a project for advancement
  - Board considers staff recommendations and decides whether to advance project to the next stage

Project Advancement Criteria

Transit Supportive Land Use and Access

- Existing Land Use: Residential and/or Employment
- Existing Intermodal Connections
- Land Use Plans and Policies

Ridership Development Plan

- Ridership Threshold
- Station Context

Cost-Effectiveness

- Cost per New Rider: Base Case
- Cost per New Rider: with TOD
- Cost per Transportation System User Benefit

Regional Network Connectivity

- Regional Transportation Gap Closure

System and Financial Capacity

- Core System Improvements
- Capital Finance Plan
- Operating Finance Plan

Partnerships

- Community and Stakeholder Support

Metrics for Staff Recommendations

PROPOSED CRITERIA	PROJECT STATUS	
	Strategic Opportunity Assessment	Environmental Clearance/ Ridership Development Plan
Transit Supportive Land Use and Access		
Existing Land Use: Residential and/or Employment	L/LM/M/MH/H	L/LM/M/MH/H
Existing Intermodal Connections	L/LM/M/MH/H	L/LM/M/MH/H
Land Use Plans and Policies	L/LM/M/MH/H	L/LM/M/MH/H
Ridership Development Plan (Comprehensive Station Plan)		
Ridership Threshold		L/LM/M/MH/H
Station Context		L/M/H
Cost Effectiveness		
Cost per New Rider: Base Case	L/LM/M/MH/H	L/LM/M/MH/H
Cost per New Rider: with TOD	L/LM/M/MH/H	L/LM/M/MH/H
Cost per Transportation System User Benefit		L/LM/M/MH/H
Regional Network Connectivity		
Regional Transportation Gap Closure	L/M/H	L/M/H
System and Financial Capacity		
Core System Improvements	L/LM/M/MH/H	L/LM/M/MH/H
Capital Finance Plan	L/M/H	L/M/H
Operating Finance Plan	L/M/H	L/M/H
Partnerships		
Community and Stakeholder Support	L/LM/M/MH/H	L/LM/M/MH/H

Rating Legend

L: Low LM: Low-Medium M: Medium MH: Medium-High H: High

Transit Supportive Land Use and Access

Existing Land Use: Residential	Low	Low-Medium	Medium	Medium-High	High
Residential Density (units per *gross* acre)	< 5	5-9	10-14	15-24	> 25
Residential Density (units per *net* acre)	< 15	16-25	26-45	46-75	> 75
Total Units w/i 1/2 mile radius	< 2,500	2,501-5,000	5,001-7,500	7,501-12,500	> 12,500
Estimated Trips at **30%** mode share**	< 1,800	1,801-3,600	3,601-5,400	5,401-9,000	> 9,000

* Residential units within ½ mile radius of stations

** Estimated trips (two-way) based on 1.2 workers per household.

Examples of Residential Density
within 1/2 mile radius of BART Stations

	Low	**Low-Medium**	**Medium**	**Medium-High**	**High**
Net	North Berkeley BART (10+ du/a)	MetroWalk Richmond BART (20+ du/a)	Strobridge Court Castro Valley BART (41 du/a)	Coggins Square Pleasant Hill BART (58 du/a)	Gaia Building Berkeley BART (250 du/a)

Gross*	Orinda (2 du/a)	Rockridge (9 du/a)	Ashby (11 du/a)	16th Street (22 du/a)	Civic Center (42 du/a)

* Dwelling Units per Gross Acre within 1/2 mile of station (Cervero, 1990)

Transit Supportive Land Use and Access

Existing Land Use: Employment	**Low**	**Low-Medium**	**Medium**	**Medium-High**	**High**
Employment Density (employees per *gross* acre)*	< 10	10-20	21-50	51-100	> 100
Million Sq. Ft. of Commercial Space w/i ½ mile radius	< 1.7	1.7–3.3	3.4-8.3	8.4-16.6	> 16.6
Total Employees w/i 1/2 mile radius	< 5,100	5,100-9,900	9,901-24,900	24,901-49,800	> 49,800
Estimated Trips at **10%** mode share**	< 1,000	1,000-2,000	2,001-5,000	5,001-10,000	> 10,000

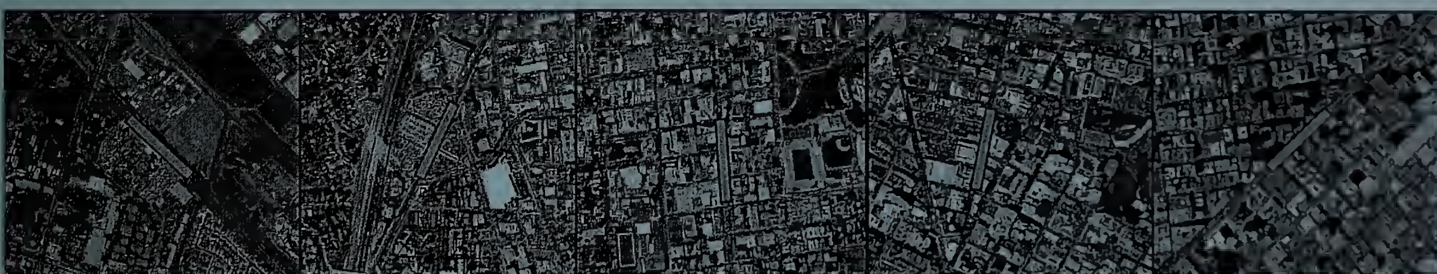
* Employment within 1/2 mile radius of stations

** Estimated trips (two-way) based on 3 employees per 1,000 square feet.

Examples of Employment Density

within 1/2 mile radius of BART Stations

	Low	Low-Medium	Medium	Medium-High	High
Gross*	Union City (2)	Walnut Creek (19)	Berkeley (24)	19th Street (65)	Montgomery (234)



* Employees per Gross Acre within 1/2 mile of station (Cervero, 1990)

Transit Supportive Land Use and Access

Existing Intermodal Connections	Low	Low-Medium	Medium	Medium-High	High
Pedestrian		*Qualitative Assessment*			
Bicycle		*Qualitative Assessment*			
Transit		*Qualitative Assessment*			

Pedestrian
·Comprehensiveness of Pedestrian Network
·Safe Access to Station Sites
·Topography

Bicycle
·Bicycle Network Connectivity
·Existing Bicycle Usage
·Comprehensiveness of Bicycle Network

Transit
·Peak-Hour Transit Routes
·Peak-Hour Routes w/ Headways 15 Minutes or Less
·Evening & Weekend Routes

Transit Supportive Land Use and Access

	Low	Low-Medium	Medium	Medium -High	High
Land Use Plans and Policies		***Qualitative Assessment***			

Growth Management	• Concentration of development around established activity centers and regional transit
Transit Supportive	• Plans and policies to increase corridor and station area development
Corridor Policies	• Plans and policies to enhance transit-friendly character of station area development
	• Commitment to inter-jurisdictional consensus on land use
Supportive Zoning	• Zoning that increases development density in transit station areas
Regulations Near	• Zoning that encourages mixed-use development
Transit Stations	• Zoning that enhances transit-oriented character of area, and pedestrian access
	• Zoning that reduces parking and traffic mitigation
Tools to Implement	• Community outreach in support of land use planning
Land Use Policies	• Regulatory and financial incentives to promote transit support development

Ridership Development Plan

(Comprehensive Station Plan)

Ridership Threshold*	Low	Low-Medium	Medium	Medium-High	High
BART	<5,000	5,000-9,999	10,000-13,999	14,000-20,000	>20,000
Other Rail Technology		*% of BART per mile capital costs*			
Express Bus/Bus Rapid Transit		*% of BART per mile capital costs*			

Includes:

- Station Area Development
- Station Access
- Station Capacity & Functionality

* Thresholds based on corridor-wide station average for daily trips to and from (*entries and exits*) new stations in horizon year with planned transit-oriented development and access improvements

Ridership Development Plan
(Comprehensive Station Plan)

	Low	Medium	High
Station Context	*Qualitative Assessment*		

Low: Station location that would not support transit-oriented development and that would negatively affect the quality of the station experience for patrons (i.e. freeway median)

Medium: Station location with good potential for transit-oriented development and an acceptable station experience for patrons

High: Station location that already has or would greatly facilitate transit-oriented development and would provide a good experience for patrons (i.e. downtown locations)

Cost Effectiveness

	Low	Low-Medium	Medium	Medium-High	High
Cost per *New* Rider - Base Case	>$40.00	$25.01-40.00	$15.01 – 25.00	$10.00 – 15.00	<$10.00

	Low	Low-Medium	Medium	Medium-High	High
Cost per *New* Rider - with TOD	>$40.00	$25.01-40.00	$15.01 – 25.00	$10.00 – 15.00	<$10.00

(Costs in 2002 dollars)

Cost Effectiveness

	Low	Low-Medium	Medium	Medium-High	High
Cost/Transportation System User Benefit	TBD	TBD	TBD	TBD	TBD

The cost effectiveness – transportation system user benefits measure is defined as a multimodal measure of perceived travel time for all transportation system users in the forecast year, divided by the recommended cost of the project. The new measure ***de-emphasizes*** *new riders and instead measures the benefits for users changing modes as well as existing transit riders and highway users. The cost effectiveness – transportation system user benefits measure will be phased in over time, becoming effective on September 1, 2001.*

Federal Transit Administration – Frequently Asked Questions on New Starts Final Rule

Regional Network Connectivity

	Low	Medium	High
Regional Transportation Gap Closure	***Qualitative Assessment***		

Assess the interconnected relationship of the transit expansion project and the existing transportation network, identifying opportunities for major gap closures (i.e., airport, inter-city rail, commuter rail, light rail).

System and Financial Capacity

	Low	Medium	High
Core System Improvements	*Qualitative Assessment*		

<u>**Enhances (at best) or minimizes demands on core system:**</u>

- **Yard/Support Facilities**
- **Redundancy/Recovery Capabilities**
- **Station and Line Haul Capacity**

System and Financial Capacity

	Low	Medium	High
Capital Finance Plan*	***Qualitative Assessment***		

* Capital Finance Plan rating based on:

1) A fully-funded project;
2) The stability, reliability and availability of proposed funding sources; and
3) Funding sources <u>not</u> competing with those that can be used for BART System Renovation and Core System Capacity needs (i.e. RTP/CMAQ or RIP).
4) For projects outside the District - funding sources <u>not</u> competing with those that can be used for District extensions.
5) For projects outside the District - core system improvements are funded in the Capital Financial Plan for the project.
6) For project inside the District - core system improvements are funded in a parallel financial plan.

System and Financial Capacity

	Low	Medium	High
Operating Finance Plan*	***Qualitative Assessment***		

* Operating Finance Plan rating based on:

1) Estimated farebox recovery (Low: <30%; Medium: 30-50%; and High: >50%);

2) The stability, reliability and availability of proposed operating subsidy.

3) For projects outside the District - funding sources that do not draw on, or risk the use of, District operating revenues.

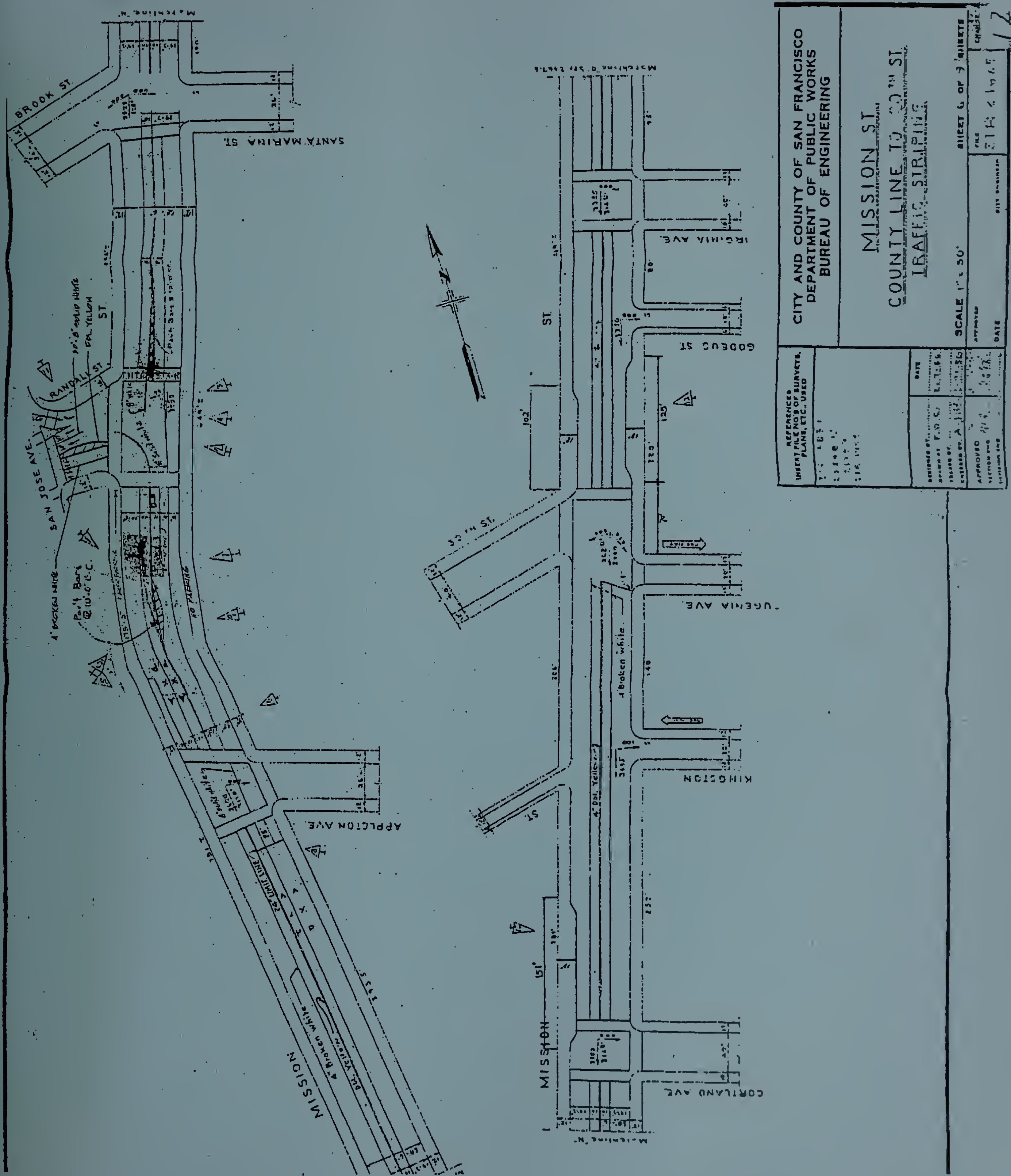
Partnerships

	Low	Low-Medium	Medium	Medium-High	High
Community and Stakeholder Support	***Qualitative Assessment***				

Community Support	•	**Degree of Support**
Stakeholder Support	•	**Degree of Support**

APPENDIX B

CITY OF SAN FRANCISCO TRAFFIC DATA


CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING
MISSION ST.
COUNTY LINE TO 30TH ST.
TRAFFIC STRIPING
SCALE 1" = 50'
BROOK ST.
SANTA MARINA ST.
RANDALL ST.
SAN JOSE AVE.
APPLETON AVE.
GODEUS ST
CORTLAND AVE.
KINGSTON
30TH ST.
MISSION
MISSION
4" Broken White
4" Dbl. Yellow
4' Broken White

Mission St. South of Cesar Chavez St.
Monday, February 26, 2001
North Bound

HOUR OF DAY	QUARTER HOUR 1st	2nd	3rd	4th	HOUR TOTAL	EACH * REPRESENTS 35 VEHICLES A DASH MEANS HOUR VOLUME < 18
12 AM	33	34	40	28	135	****
1 AM	22	23	15	43	103	***
2 AM	33	22	16	7	78	**
3 AM	15	18	14	13	60	**
4 AM	20	13	19	16	68	**
5 AM	23	33	53	50	159	*****
6 AM	57	71	88	113	329	*********
7 AM	124	179	235	256	794	***********************
8 AM	247	248	236	179	910	**************************
9 AM	168	147	138	123	576	****************
10 AM	154	125	119	125	523	***************
11 AM	119	143	134	152	548	****************
12 PM	145	166	153	169	633	******************
1 PM	163	130	154	163	610	*****************
2 PM	187	168	135	149	639	******************
3 PM	175	148	178	182	683	********************
4 PM	161	176	166	171	674	*******************
5 PM	189	164	166	173	692	********************
6 PM	153	153	128	162	596	*****************
7 PM	123	141	135	127	526	***************
PM	117	111	104	113	445	*************
9 PM	97	85	95	95	372	***********
10 PM	75	80	69	66	290	********
11 PM	60	70	47	48	225	******

TOTAL VOLUME IS 10,668 VEHICLES.

PEAK HOURS:
MORNING PEAK HOUR VOLUME OF 987 BEGINS AT 7:45 AM (9 %)
EVENING PEAK HOUR VOLUME OF 702 BEGINS AT 4:15 PM (7 %)

DATA COLLECTION BEGAN AT 3 pm ON SUNDAY,FEBRUARY 26, 1928.

WEATHER: clear
BY J.D.C. FOR G.D.
COUNTER # 3
COUNT # 01070

Mission St. North of Cesar Chavez St.
Monday, February 26, 2001
South Bound

OUR OF DAY	---- QUARTER HOUR ---- 1st	2nd	3rd	4th	HOUR TOTAL	EACH * REPRESENTS 25 VEHICLES A DASH MEANS HOUR VOLUME < 13
2 AM	42	40	42	39	163	*******
1 AM	29	30	27	36	122	*****
2 AM	25	20	23	10	78	***
3 AM	11	8	15	17	51	**
4 AM	5	14	15	13	47	**
5 AM	22	17	29	30	98	****
6 AM	31	46	57	61	195	********
7 AM	52	69	81	72	274	***********
8 AM	84	93	111	101	389	****************
9 AM	97	80	80	91	348	**************
0 AM	107	90	101	113	411	****************
1 AM	91	117	114	83	405	****************
12 PM	121	142	134	117	514	*********************
1 PM	143	141	139	111	534	*********************
2 PM	127	132	141	106	506	********************
3 PM	132	146	139	150	567	***********************
4 PM	123	153	148	158	582	***********************
5 PM	147	186	174	163	670	***************************
6 PM	166	150	133	117	566	***********************
7 PM	113	105	99	105	422	*****************
M	95	81	73	96	345	**************
M	104	91	55	59	309	************
10 PM	73	64	60	54	251	**********
1 PM	40	48	42	43	173	*******

OTAL VOLUME IS 8,020 VEHICLES.

EAK HOURS:
MORNING PEAK HOUR VOLUME OF 435 BEGINS AT 10:45 AM (5 %)
EVENING PEAK HOUR VOLUME OF 689 BEGINS AT 5:15 PM (9 %)

TA COLLECTION BEGAN AT 2 pm ON SUNDAY,FEBRUARY 26, 1928.

WEATHER: clear
BY J.D.C. FOR G.D.
COUNTER # 1
COUNT # 01071

3. TURNING MOVEMENT COUNT DATA

3.1 Data Collected

The turning movement counts were carried out in order to determine both through movements and turning movements at various intersections within the Study Area. This information is required in order to:

- establish the functional classification of the street;
- assess the suitability of appropriate traffic calming measures; and
- evaluate the project effects and impacts.

The counts were undertaken at locations where the working group expressed concerns about pedestrian safety, cut-through traffic and localized congestion. The surveys were conducted during the months of March, April and May 2001 between 7:00 AM and 9:00 AM (the morning peak period), and 4:00 PM and 6:00 PM (the evening peak period).

3.2 Data Collection Results

The results of the intersection survey counts for the peak hour periods are illustrated geographically on Figures 3.1 and 3.2; while, the volumes along the main roads within the Study Area are summarized in Table 3.1.

Table 3.1: Summary of Peak Hour Volumes

Street	Between		AM Peak Hour (Two-way)	PM Peak Hour (Two-way)
Winfield St	Esmeralda Ave	Coso Ave	24	39
Godues St	Mission St	Coleridge ST	31	60
Leslie St	Mission St	Park St	31	27
Powers Ave	Mission St	Coleridge ST	37	24
Park Street	Mission St	Leslie St	38	71
Eugenia Ave	Mission St	Coleridge ST	40	128
Prospect Ave	Lundy's Ln	Coso Ave	46	104
Highland Ave	Mission St	Patton St	50	72
Ellsworth St	Powhattan Ave	Bernal Heights Blvd	58	101
Kingston St	Mission St	Coleridge ST	59	31
Coleridge St	Fair Ave	Powers Ave	71	70
Elsie St	Esmeralda Ave	Coso Ave	91	123
Fair Ave	Mission St	Coleridge ST	92	114
Bocana St	Holly Park Cir	Cortland Ave	98	81
Santa Marina	Mission St	Gladys St	98	99
Andover St	Cortland Ave	Eugenia Ave	99	109
Ellsworth St	Crescent Ace	Alemany Blvd	96	150
Folsom St	Cortland Ave	Eugenia Ave	105	63
Coso Ave	Winfield St	Elsie St	106	136
Bocana St	Cortland Ave	Eugenia Ave	121	119
Coso Ave	Prospect Ave	Winfield St	122	152
Coso Ave	Coleridge ST	Prospect Ave	132	156
Appleton Ave	Mission St	Gladys St	134	116
Folsom St	Jarboe Ave	Cortland Ave	137	84
Putnam St	Alemany Blvd	Tompkins Ave	151	148

Street	Between		AM Peak Hour (Two-way)	PM Peak Hour (Two-way)
Coso Ave	Elsie St	Bonview St	153	203
Richland Ave	Mission St	Leslie St	163	169
Virginia Ave	Mission St	Coleridge St	205	189
Andover St	Elbert St	Cortland Ave	303	166
Murray St	Mission St	Genebern Way	406	313
Justin Drive	Benton Ave	Alemany St	342	338
Crescent Ave	Mission St	Leslie St	407	398
Crescent Ave	Alemany Blvd	Nevada St	566	527
Cortland Ave	Gates St	Folsom St	636	642
Cortland Ave	Peraalta Ave	Bayshore Blvd	662	684
Cortland Ave	Mission St	Coleridge St	669	690
Cortland Ave	Bonview St	Bocana St	674	674
Cortland Ave	Folsom St	Bank St	678	645
Cortland Ave	Bocana St	Bennington St	703	674
Cortland Ave	Wool St	Andover St	728	688
Cortland Ave	Andover St	Moultrie St	778	821

A summary of the main findings of the survey data is provided below:

- during both the morning and evening peak periods Cortland Avenue was the busiest street within the Study Area. The busiest section of this street was between Andover Street and Moultrie Street with 778 vehicles in am peak and 821 vehicles in the pm peak.
- analysis of the directional distribution during the am peak hour along Cortland Avenue shows that between Andover Street and Bayshore Boulevard 60% of the traffic was eastbound; while, between Andover Street and Mission Street 55% of the traffic was traveling westbound. During the pm peak the following directional patterns were displayed, 51% of traffic between Andover Street and Bayshore Boulevard was westbound increasing to 60% between Andover Street and Mission Street.
- the busiest intersection within the Study Area, during both peak periods, was Cortland Avenue and Andover Street the total number of vehicles making manoeuvres was 942 and 842, for the am and pm peak hours, respectively.
- turning movement counts were undertaken at all the streets within the Study Area that intersect with Mission Street. The purpose of these counts was to identify the level of cut-through traffic that uses the local streets instead of the two main collector streets (i.e.: Cortland and Crescent Avenue). Interpretation of the intersection count data shows that the only local streets within in excess of 200 vehicles per hour were Murray Street and Virginia Avenue.

3.3 Conclusions

Excessive traffic volume in residential areas is associated with queuing, aggressive driving and cut-through traffic. During the outreach effort the community had expressed concerns about traffic levels on several streets within the Study Area. However, the results of the traffic survey demonstrate that volumes are generally light. The only streets where the level of traffic seems inappropriate for their respective function were:

- the intersection with Murray Street and Mission Street;

5. ACCIDENT DATA OBTAINED

5.1 Data Collected

The DPT provided a detailed collision database for the Bernal Heights area. The database contains collision information from 1995 to 1999.

5.2 Data Collection Results

The collision data was processed and separated into three categories; Pedestrian Collisions, Injury Collisions, and Total Collisions.

5.2.1 Pedestrian Collisions

Pedestrian Collisions are collisions that involve a pedestrian and one or more vehicles. The ten intersections with the most pedestrian collisions are summarized in Table 5.1 and are discussed below.

Table 5.1: Pedestrian Collisions (1995 – 1999)

Rank	Location	Number of Pedestrian Collisions
1	Cortland Ave and Mission St	8
2	Eugenia Ave and Mission St	5
3	Virginia Ave and Mission St	4
3	Richland Ave and Mission St	4
5	Cortland Ave and Ellsworth St	3
5	Godeus St and Mission St	3
5	Murray St and Mission St	3
5	Crescent Ave and Alemany Blvd	3
9	Cortland Ave and Bradford St	2
9	Cortland Ave and Andover St	2

The intersections along Mission Street comprised 60% of the top 10 pedestrian collision locations and intersections along Cortland Avenue comprised 30%. Alemany Boulevard was only sited once in the top ten.

5.2.2 Injury Collisions

Injury collisions are collisions that result in an injury to either a vehicle occupant and/or a bystander. The top 10 intersections with the most injury collisions are summarized in Table 5.2.

Table 5.2: Injury Collisions (1995 – 1999)

Rank	Locations	Number of Injuries
1	Crescent Ave and Alemany Blvd	58
2	Fair Ave and Mission St	35
3	Eugenia Ave and Mission St	30
4	Cortland Ave and Mission St	26
5	Ellsworth St and Alemany Blvd	23
6	Murray St and Mission St	16
7	Justin Dr and Alemany Blvd	15

Rank	Locations	Number of Injuries
8	Richland Ave and Mission St	13
9	Virginia Ave and Mission St	12
10	Highland Ave and Mission St	12

Analysis of the data shows that the intersection of Crescent Avenue and Alemany Boulevard is ranked number one in the top 10 injury collision list. The intersections along Mission Street comprised 70% of the top 10 injury collision list.

5.2.3 Total Collisions

Figures 5.1 and 5.2 show the total collisions over the 4-year period at each intersection in the Study Area; while, the 10 intersections with most reported collisions are summarized in Table 5.3.

Table 5.3: Total Collisions (1995-1999)

Rank	Locations	Number of Collisions
1	Crescent Ave and Alemany Blvd	54
2	Fair Ave and Mission St	28
3	Ellsworth St and Alemany Blvd	27
3	Eugenia Ave and Mission St	27
5	Cortland Ave and Mission St	23
6	Virginia Ave and Mission St	17
7	Murray St and Mission St	15
8	Folsom St and Alemany Blvd	12
9	Richland Ave and Mission St	11
9	Highland Ave and Mission St	11

Interpretation of the survey results show that the intersection of Crescent Avenue and Alemany Boulevard had the most collisions in the Study Area between 1995-1999. The intersections along Alemany Boulevard comprised 30% of the top 10 and intersections along Mission Street comprised 70% of the top 10.

5.3 Conclusions

Interrogation of the DPT accident database showed that the intersections along Alemany Boulevard and Mission Street accounted for over 50% of all accidents in the Study Area. There were also a high number of recorded pedestrian accidents along Cortland Avenue – this issue will need to be addressed during the development of the traffic calming plan.

This accident trend illustrates that the highest numbers of accidents generally occurred at locations with relatively high traffic volumes and pedestrian movements. This pattern is normal, as a greater number of conflicts occur at locations with higher volumes of both traffic and pedestrians.

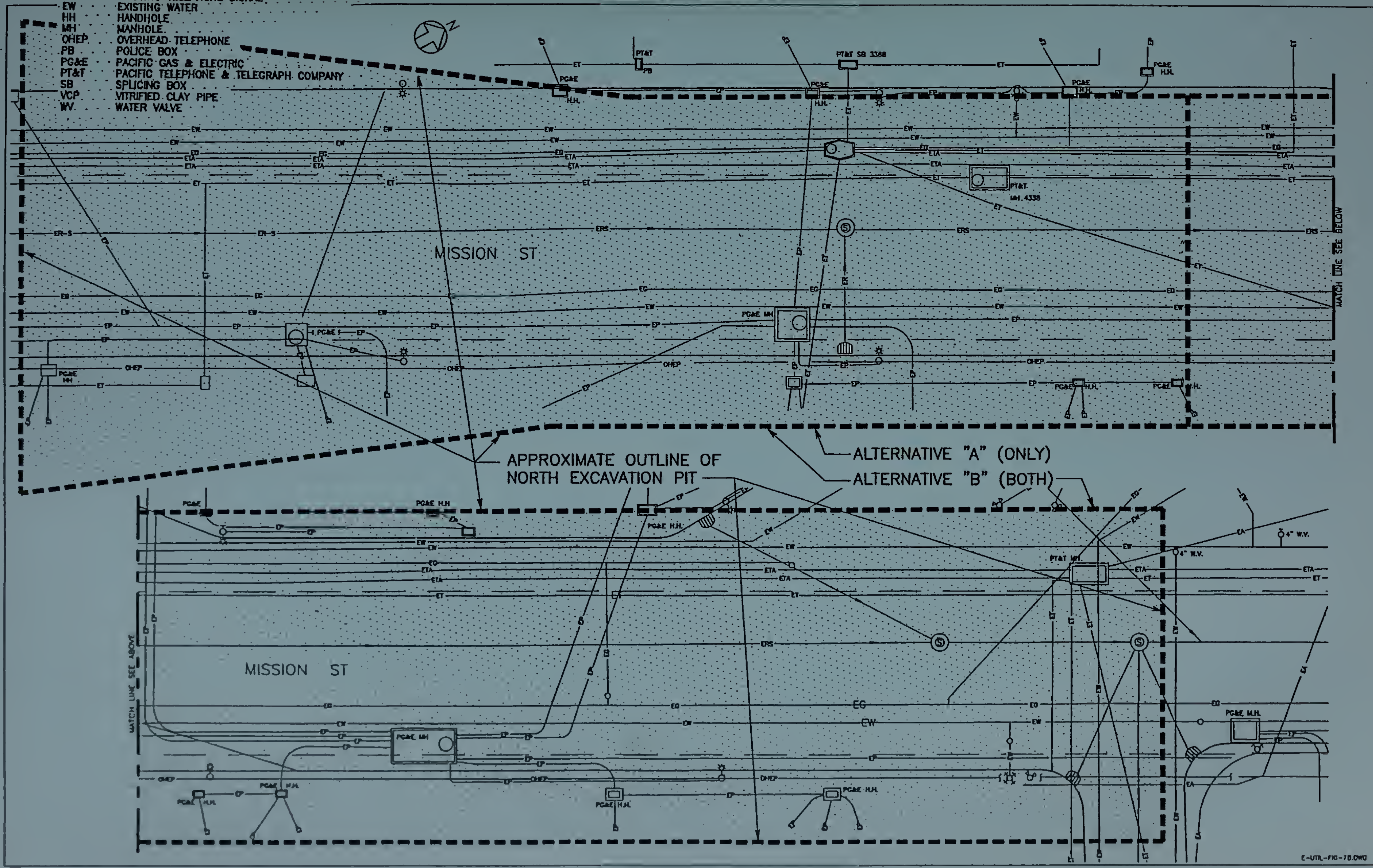
The one exception to this trend is Patton Street, which has relatively low flows of traffic and pedestrian. However, over the four-year period investigated there have been 5 recorded accidents, between Highland Avenue and Appleton Avenue. All the 5 accidents were vehicle oriented; therefore no pedestrians or bicyclists were injured. Further analysis of the database shows the reasons for this anomaly:

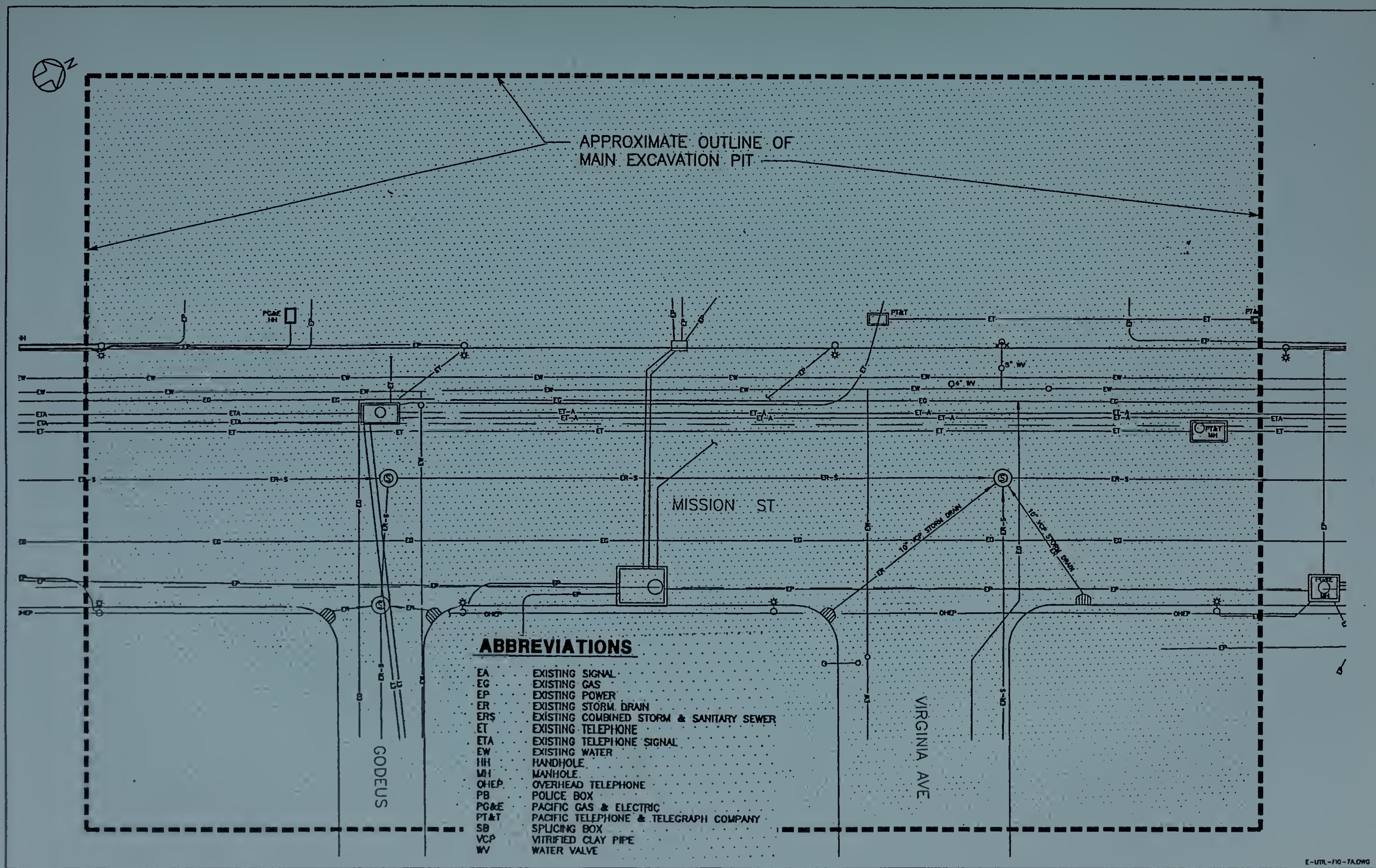
APPENDIX C

EXISTING UTILITY MAPS

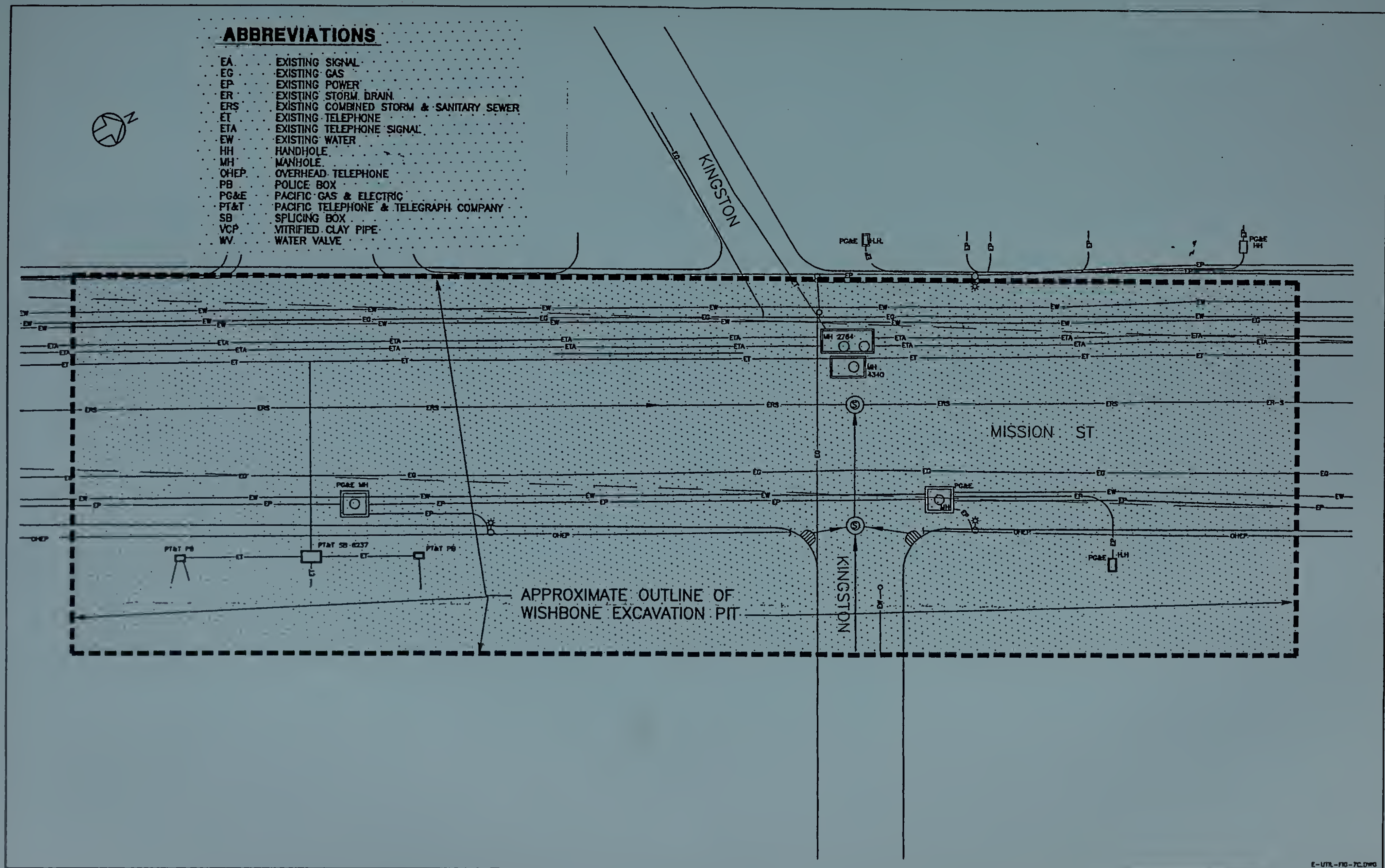
ABBREVIATIONS

EA	EXISTING SIGNAL
EG	EXISTING GAS
EP	EXISTING POWER
ER	EXISTING STORM DRAIN
ERS	EXISTING COMBINED STORM & SANITARY SEWER
ET	EXISTING TELEPHONE
ETA	EXISTING TELEPHONE SIGNAL
EW	EXISTING WATER
HH	HANDHOLE
MH	MANHOLE
OHEP	OVERHEAD TELEPHONE
PB	POLICE BOX
PG&E	PACIFIC GAS & ELECTRIC
PT&T	PACIFIC TELEPHONE & TELEGRAPH COMPANY
SB	SPLICING BOX
VCP	VITRIFIED CLAY PIPE
WV	WATER VALVE



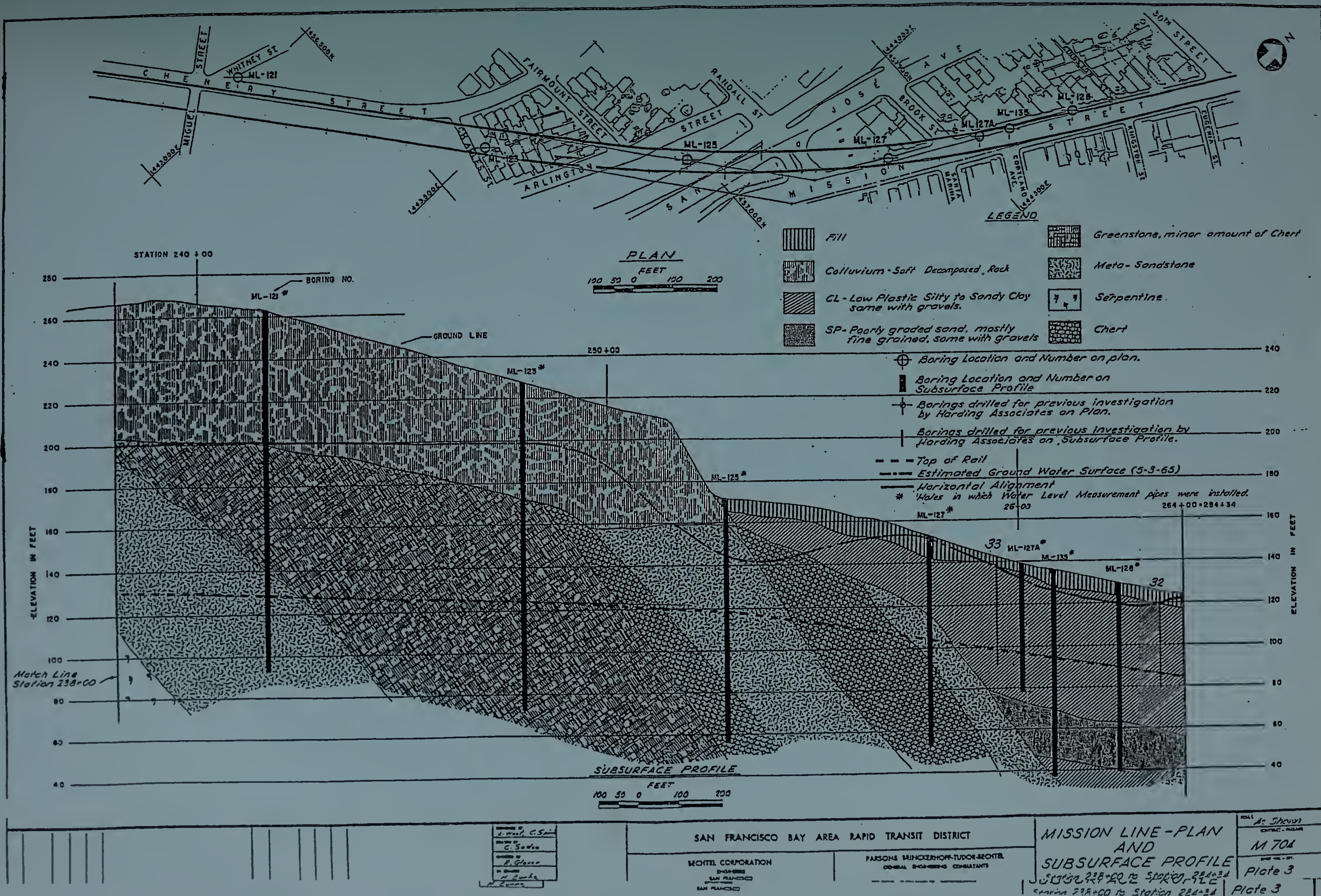


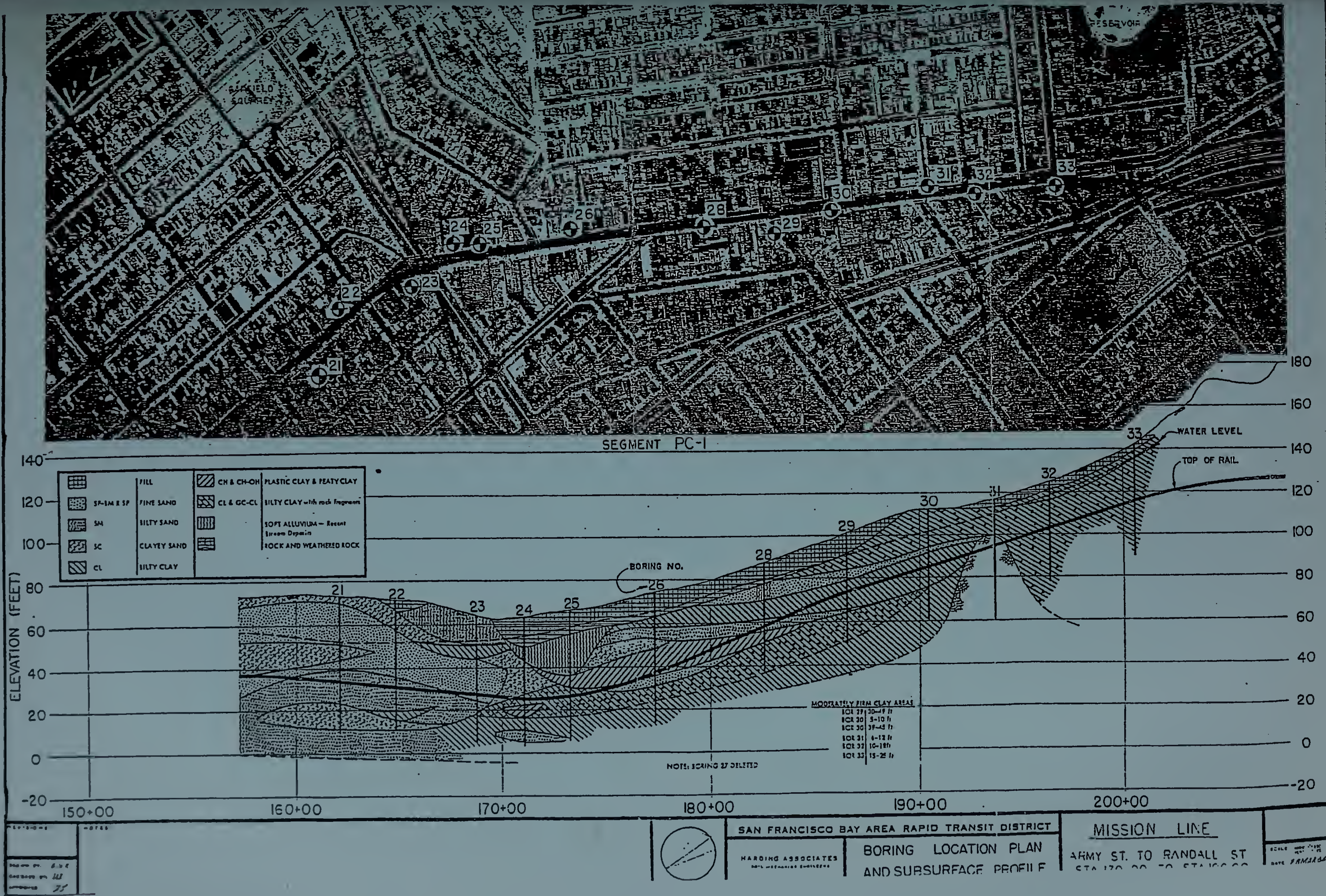
APPROXIMATE OUTLINE OF MAIN EXCAVATION PIT
MISSION ST
GODEUS
VIRGINIA AVE
10" VCP STORM DRAIN
10" VCP STORM DRAIN
4" WV
3" WV
PT&T
PT&T MH
PG&E HH
ABBREVIATIONS
EA EXISTING SIGNAL
EG EXISTING GAS
EP EXISTING POWER
ER EXISTING STORM DRAIN
ERS EXISTING COMBINED STORM & SANITARY SEWER
ET EXISTING TELEPHONE
ETA EXISTING TELEPHONE SIGNAL
EW EXISTING WATER
HH HANDHOLE
MH MANHOLE
OHEP OVERHEAD TELEPHONE
PB POLICE BOX
PG&E PACIFIC GAS & ELECTRIC
PT&T PACIFIC TELEPHONE & TELEGRAPH COMPANY
SB SPLICING BOX
VCP VITRIFIED CLAY PIPE
WV WATER VALVE
E-UTIL-FIG-7A.DWG


ABBREVIATIONS
EA EXISTING SIGNAL
EG EXISTING GAS
EP EXISTING POWER
ER EXISTING STORM DRAIN
ERS EXISTING COMBINED STORM & SANITARY SEWER
ET EXISTING TELEPHONE
ETA EXISTING TELEPHONE SIGNAL
EW EXISTING WATER
HH HANDHOLE
MH MANHOLE
OHEP OVERHEAD TELEPHONE
PB POLICE BOX
PG&E PACIFIC GAS & ELECTRIC
PT&T PACIFIC TELEPHONE & TELEGRAPH COMPANY
SB SPLICING BOX
VCP VITRIFIED CLAY PIPE
WV WATER VALVE
N
KINGSTON
MISSION ST
KINGSTON
MH 2764
MH 4340
PG&E MH
PG&E H.H.
PG&E HH
PT&T PB
PT&T SB 6237
APPROXIMATE OUTLINE OF
WISHBONE EXCAVATION PIT
E-UTIL-FIG-7C.DWG

APPENDIX D

SOILS DATA


PLAN
FEET
100 50 0 100 200
LEGEND
Fill
Colluvium - Soft Decomposed Rock
CL - Low Plastic Silty to Sandy Clay some with gravels.
SP - Poorly graded sand, mostly fine grained, some with gravels
Greenstone, minor amount of Chert
Meta - Sandstone
Serpentine
Chert
Boring Location and Number on plan.
Boring Location and Number on Subsurface Profile
Borings drilled for previous investigation by Harding Associates on Plan.
Borings drilled for previous investigation by Harding Associates on Subsurface Profile.
Top of Rail
Estimated Ground Water Surface (5-3-65)
Horizontal Alignment
* Holes in which Water Level Measurement pipes were installed.
CHENERY STREET
WHITNEY ST
MIGUEL STREET
FAIRMOUNT STREET
CHARLES ST
ARLINGTON
RANDALL ST
SAN JOSE AVE
BROOK ST
MISSION STREET
SANTA MARINA
CORTLAND AVE.
KINGSTON ST
EUGENIA ST
30TH STREET
ML-121
ML-123
ML-125
ML-127
ML-127A
ML-135
ML-128
STATION 240+00
BORING NO.
GROUND LINE
250+00
264+00=284+34
ELEVATION IN FEET
Match Line Station 238+00
SUBSURFACE PROFILE
FEET
100 50 0 100 200
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT
BECHTEL CORPORATION
PARSONS BRINCKERHOFF-TUDOR-BECHTEL
MISSION LINE - PLAN AND SUBSURFACE PROFILE
Station 238+00 to Station 284+34
M 704
Plate 3


SEGMENT PC-1
BALFIELD SQUARE
RESERVOIR
21
22
23
24
25
26
28
29
30
31
32
33
ELEVATION (FEET)
FILL
SP-SM & SP FINE SAND
SM SILTY SAND
SC CLAYEY SAND
CL SILTY CLAY
CH & CH-OH PLASTIC CLAY & PEATY CLAY
CL & GC-CL SILTY CLAY with rock fragments
SOFT ALLUVIUM — Recent Stream Deposits
ROCK AND WEATHERED ROCK
BORING NO.
WATER LEVEL
TOP OF RAIL
MODERATELY FIRM CLAY AREAS
NOTE: BORING 27 DELETED
150+00
160+00
170+00
180+00
190+00
200+00
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT
HARDING ASSOCIATES
BORING LOCATION PLAN
AND SUBSURFACE PROFILE
MISSION LINE
ARMY ST. TO RANDALL ST

APPENDIX E

Bay Area Rapid Transit District

BART STAFF LISTING OF STATION CRITERIA

Proposed In-Fill Station Criteria 30th St

1. Maximum track gradient, 1.5%
2. Because of maximum track gradient requirements and constructability issues, station must be off-line.
3. Provide turnback and double-ended pocket track for operating flexibility.
4. Provide dispatch capability to the South
5. All vertical circulation elements (i.e. stairways, elevators, and escalators) must touch down on platform with gradient that does not exceed 1.5%. Vertical transitions to off-line platforms from the main line may encroach in platform areas beyond the central touch down space reserved for vertical circulation elements. This encroachment shall not exceed 150' from the ends of station.
6. Allow two-way traffic on an off-line center pocket track configuration if station pocket has double wishbone track connections and overlapped interlockings designed to preclude unsafe train movements.
7. In addition to provisions for turnback facilities, consider providing a bad order/ hold track that does not interfere with normal train operations.
8. Maximum track gradient for short vertical track transitions to off-line platforms shall be 4% in the normal uphill direction of train movement and 5-1/2% in the normal downhill direction.
9. Turnouts to off-line station platforms and/or pocket tracks shall be #15 std. And #10 Eq. (36MPH)
10. Station concepts must be constructable under conditions acceptable to BART operations.
11. BART operating moves may include the following:
    a. Train by-pass (skip stop)
    b. Turnback
    c. Off-peak or bad order hold (10 cars)
    d. Single tracking for maintenance

12. Concept shall consider and discuss impacts on BART systemwide operations and extensions planning.

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

PROJECT: 30TH AND MISSION STREET STATION, SAN FRANCISCO
CONTRACT NO. / WORK ORDER NO.: - - - - - - - - - - - - - - - - -
SUBMITTAL#: TRANSMITTAL #01
Document: 30TH AND MISSION STREET INFILL STATION STUDY
Reviewer: R.AVERY / M.CHIU / J.GARCIA / H.S.AGROIA **Discipline:** ENGINEERING **Discipline Chief:** Colin McDonald

Date: 7-20-01
Due Date: 7-20-01
Sheet: 1 of 7

REF NO.	Potential Operating Constraints/Issues	Comments	Remarks
1	What is the maximum gradient for station platforms? Gradient for an on-line station at 30th Street would be 3.12%.	The desirable gradient through stations is zero. The maximum gradient shall be 1.0% through stations per Design Criteria volume I Civil Section 3.8. **ADAAG** Requirements/Regulations: Refer to two attached files (30thsta8.mlm & 30thsta9.mlm) from Jeff Garcia on the subject. From an ADA standpoint we need to maintain a constant grade along the platform. ADA requires that the platform be level. It defines level as a maximum gradient of 1:50 (2.0%) on a constant plane in any direction. However, to allow for platform drainage, the platform should also have a cross-slope within these requirements. If a std. cross-slope of 1.5% is used, the corresponding maximum allowable longitudinal slope is then 1.322%. We could theoretically maximize the longitudinal gradient and still be within ADA compliance (i.e. 1.0% cross-slope and 1.732% longitudinal slope), however then we'd have to also look at potential vehicle slippage and other issues caused by steeper slope, however minor it may appear. (Most existing BART stations are constructed on a 0.0% slope.) Needless to say, an on-line station with a grade of 3.12% would not be allowed under the ADA.	

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

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CONTRACT NO. / WORK ORDER NO.: - - - - - - - - - - - - - - - - -
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Reviewer: R.AVERY / M.CHIU /J.GARCIA / H.S.AGROIA **Discipline:** ENGINEERING **Discipline Chief:** Colin McDonald

Date: 7-20-01
Due Date: 7-20-01
Sheet: 2 of 7

REF NO.	Potential Operating Constraints/Issues	Comments	Remarks
2	Should the station be developed as an on-line or off-line facility?	I believe that it should be on-line as an off-line stations need turnouts at each end of the station on each track. This will unneccessarily decrease line reliability to meet schedule. An existing on-line station (24th Street @ Mission) is only 0.6 miles from this location.	
3	How would an on-line or off-line station effect train operations and scheduling?	An on-line station will increase run / schedule time by about 1 to 2 minutes which may require adding one or two trainsets (10 to 20 cars) depending on the characteristics of each service route. An off-line station would really only work in this location if it was turnback with a double-ended pocket track. This would help service reliability by enabling BART to run a service ending at 30th Street. Also refer to Rudy Crespo (Transportation).	
4	Should the off-line station be developed as a stub end terminal or through routed?	It should have a double-ended pocket track long enough for a 10 car train with short straight sections on the pocket track beyond the switches.	

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

PROJECT: **30TH AND MISSION STREET STATION, SAN FRANCISCO**
CONTRACT NO. / WORK ORDER NO.: - - - - - - - - - - - - - - - - -
SUBMITTAL#: **TRANSMITTAL #01**
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Reviewer: R.AVERY / M.CHIU / J.GARCIA / H.S.AGROIA **Discipline:** ENGINEERING **Discipline Chief:** Colin McDonald

Date: 7-20-01
Due Date: 7-20-01
Sheet: 3 of 7

REF NO.	Potential Operating Constraints/Issues	Comments	Remarks
5	Is this a desirable location for a future turnback facility? What are the related requirements for pocket track length and gradient? Can the pocket track be constructed on a curve?	Not for regular service, but yes for "shoulder" service or rush hours only. Pocket track should ideally be lower than any track it is connected to so that in the event of an accidental brake release it does not run into the mainline tracks. **Schaefer Ranch Rd. Pocket Track** on DPX has horiz. & vert. curves and is at 2% grade per Contract 08YI-110 page nos.24 & 25. **Center Spur (MC)** at north of Daly City Sta. was 570' long on a 1000' radius curve per Contract 1M4072 page 3. Also, refer to Rudy Crespo (Transportation).	
6	Is it possible to utilize a single platform station with two-way running and inbound/ outbound crossovers?	No, absolutely not with the headways we are running. Also, refer to Rudy Crespo (Transportation).	
7	What is the maximum gradient that a turnout can be installed on?	3.76% per Contract 1Z4483 page 485 (1K0061 page 21). This is the max. grade used in the system. Turnouts are not permitted on vertical curves.	
8	What is the maximum gradient for tangent running tracks?	4.0% per Design Criteria volume I Civil Section 3.5.4.1.	
9	What is the maximum gradient allowed into and out of the station for train operation?	This will be an exception to the Design Criteria volume I Civil Section 3.8. The grade should match the station grade 200 ft beyond the limits of platforms.	

PROJECT: 30^{TH} **AND MISSION STREET STATION, SAN FRANCISCO**
CONTRACT NO. / WORK ORDER NO.: - - - - - - - - - - - - - - - - -
SUBMITTAL#: TRANSMITTAL #01
Document: 30^{TH} AND MISSION STREET INFILL STATION STUDY
Reviewer: R.AVERY / M.CHIU /J.GARCIA / H.S.AGROIA **Discipline: ENGINEERING** **Discipline Chief: Colin McDonald**

Date: 7-20-01
Due Date: 7-20-01
Sheet: 4 of 7

REF NO.	Potential Operating Constraints/Issues	Comments	Remarks
10	What are the length and gradient change limits for vertical curves?	Length: Refer to Design Criteria volume I Civil section 3.6.2 for information. Rate of Change of Grade: Refer to Design Criteria volume I Civil Section 3.6.3 for information.	
11	Can a portion of the station be constructed on a vertical curve? If so, how much?	It will be very hard to build the track and platform in parallel changing planes. These MUST be accurately done in order to meet ADA requirements for train to platform elevation differences to be within plus or minus 5/8 inch. The north end of 19^{th} Street Oakland Station is on a portion of vertical & horizontal curves for approx one car length, and has restraining rail per Contract 1k0015, drawing nos. CT5 & CT6.	

PROJECT: **30^{TH} AND MISSION STREET STATION, SAN FRANCISCO** Date: 7-20-01
CONTRACT NO. / WORK ORDER NO.: - - - - - - - - - - - - - - - - - **Due Date: 7-20-01**
SUBMITTAL#: **TRANSMITTAL #01** Sheet: 5 of 7
Document: 30^{TH} AND MISSION STREET INFILL STATION STUDY
Reviewer: R.AVERY / M.CHIU /J.GARCIA / H.S.AGROIA **Discipline: ENGINEERING** **Discipline Chief: Colin McDonald**

12	What are the minimum dimensions allowed for stair width, escalator width, and platform width?	Refer to Design Criteria Volume IIIA. Stair width = 5'-6", per Section 3.2.5.2A. At the minimum , it should be at least 44" wide, however 5'-6 is more desirable for egress. Escalator width = 4 feet, per Section 3.2.4.1B. ADAAG requires that escalators have a min. clear width of 32 inches. Platform width: The minimum clearance from the platform edge to a continuous obstruction (wall, guardrail, etc.) shall be 8 feet, per Section 3.1.1D. Refer to PUC Criteria dated 3/1/89 for Occupant Load, Emergency Egress & Total Exit Time etc.. Platform width must permit two trains (one in each direction) of one thousand people to be discharged onto it concurrently with 500-1,000 passengers already there without any exiting. The stair widths must allow these passenger to be discharged in 4 minute up the stairs & 6 minutes to exit station in accordance with CBC. The escalators can be considered as a staircase of half the capacity of a staircase of the same width. The number of staircases / escalators must be such that a fire at the foot of one bank still enables the 6 minute evacuation time. The escalators must be able to move ALL the ultimate maximum number of discharging passengers per train up in 1 minute. This may require faster escalators than BART currently uses. If this is the case BART will need to increase the criteria for th number of flat steps at the top and bottom of each escalator. (For example London is apparently using 150 ft / min escalators with SIX flat steps at each end). This may result in some complex structural issues in finding the space for the escalators. Staircase layouts must not leave narrow areas on the platform that large numbers of passengers have to pass through as this becomes a bottleneck for exiting. It occurs now in SF & Dublin during rush hour. ADAAG requires that platforms have a min. clear width of 5 ft from the platform edge detection. The Platform Edge Detection is 2 ft wide, plus an additional 1 ft at center platform door locations. This means that the platform must be at least 8 ft wide from the platform edge to any obstructions. Also refer to Mark Chan (Safety).	

PROJECT: 30^{TH} **AND MISSION STREET STATION, SAN FRANCISCO**
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Date: 7-20-01
Due Date: 7-20-01
Sheet: 6 of 7

REF NO.	Potential Operating Constraints/Issues	Comments	Remarks
13	What is the minimum separation allowed for vertically stacked tunnels?	22 feet, (TOR to TOR) was used, refer to Contract 1Z4481 page 182 (Contract 1K0016 page 10).	
14	Will BART ever employ skip-stop (bypass) operation?	Refer to Rudy Crespo (Transportation).	
15	Will BART use this for off-peak layover?	Yes, if the end-of-line facilities are provided. Get further information from Transportation.	
16	What are the systemwide impacts on train headways for the various operating concepts? a) Station stop on existing mainline for all trains b) Selected trains stop in pocket track with minimal disruption to through trains c) Dead-end pocket tracks with crossovers	Refer to Rudy Crespo (Transportation).	
17	Is train dispatch required to SFIA from this location?	Refer to Rudy Crespo (Transportation). Southward dispatching will probably be needed sometimes to help recovery from train delays.	

PROJECT: **30^{TH} AND MISSION STREET STATION, SAN FRANCISCO** Date: 7-20-01
CONTRACT NO. / WORK ORDER NO.: - - - - - - - - - - - - - - - - - **Due Date: 7-20-01**
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Document: 30^{TH} AND MISSION STREET INFILL STATION STUDY
Reviewer: R.AVERY / M.CHIU /J.GARCIA / H.S.AGROIA **Discipline: ENGINEERING** **Discipline Chief: Colin McDonald**

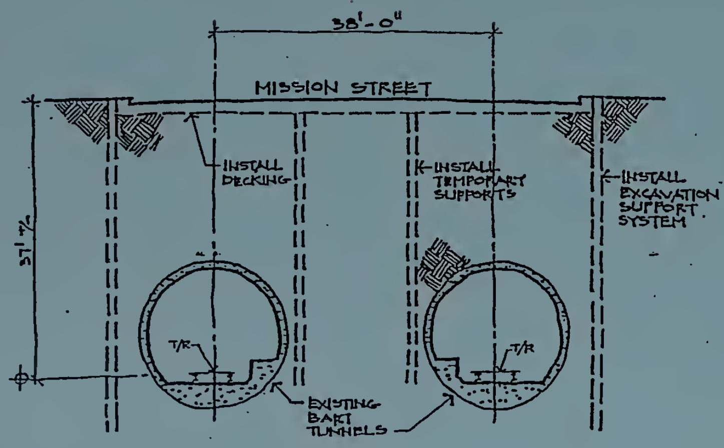
REF NO.	Potential Operating Constraints/Issues	Comments	Remarks
18	Will this station adversely effect train movements on the proposed Geary Corridor?	Refer to Rudy Crespo (Transportation).	
19	What is the preferred location for the surface intermodal center? Do we access station from one side of Mission or both?	Refer to Rudy Crespo (Transportation) and Marianne Payne (Station Area Planning Division).	
20	What are the ADA requirements for station platform development?	**ADAAG** Requirements/Regulations: Refer to two attached files (30thsta8.mlm & 30thsta9.mlm) from Jeff Garcia on the subject.	
21	Will BART accept No. 10 turnouts (27 MPH) for pocket and wye tracks?	No.10 turnouts (27 MPH) are acceptable for pocket tracks & x-overs, however No. 15 is the min. for mainline operations.	

APPENDIX F

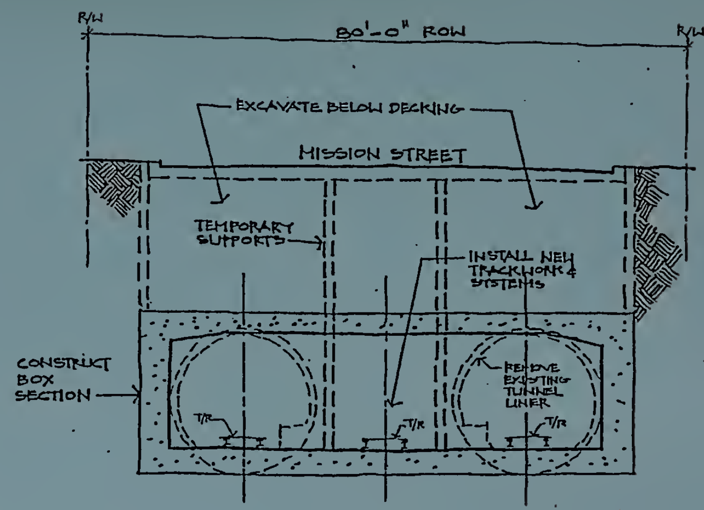
ON-LINE STATION ALTERNATIVE

Using Existing Track & Tunnel

(Bay Area Transit Consultants)



PHASE I



PHASE II

CUT & COVER CONSTRUCTION AT POCKET TRACK (STATION SIMILAR)

ELEMENTS REQUIRING FURTHER STUDY AND ENGINEERING ANALYSIS

- **Location:**
  - 1.0 miles to 24th St. Station
  - 1.2 miles to Glen Park Station
  - Good location for connections to MUNI
- **Operation:**
  - Additional station adds approximately 3 minutes to all train run times.
  - Pocket track would allow turn back of Southbound trains after stop at 24th Street Station.
  - Narrow track centers at existing mined tunnels will result in elongated concourse for vertical circulation.
- **Construction:**
  - Difficult construction within operating envelope.
  - Limits on excavation and excavation support systems due to high water table.
  - Methods and cost to support/relocate numerous existing utilities in Mission Street (cut & cover).
  - Consider bored construction for 1,000 foot pocket track section.
- **Other:**
  - Station on 3% grade (Criteria is 1% max. for stations).
  - Capital cost = $300 million* (1998 dollars).

* At this Preliminary Sketch level of design, estimate margin of error is -20% to +40%.

ON-LINE STATION ALTERNATIVE USING EXISTING TRACK & TUNNEL

APPENDIX 'F'

30TH & MISSION BART INFILL STATION STUDY

FOR STUDY PURPOSES ONLY

Apndx-f.Dwg

APPENDIX G

OTHER ALTERNATIVES CONSIDERED

The following alternatives were initially developed in this study:

Alternative 1 – Double Pocket Turnback Station with Crossovers
(Redesignated Alternative 'B' – see main text)

Alternative 2 – Single Pocket Turnback Station with Crossovers

Alternative 3 – Single Pocket Turnback Station with Stub-end Storage Track & Crossover

Alternative 4 – Two-Way Single Center Pocket Turnback Station with Third Level Platform

Alternative 5 – Stacked Back-to-Back Center Pocket Turnback Station

Alternative 6 – Double Pocket Turnback Station
(Redesignated Alternative 'A' – see main text)

Subsequently, only Alternatives 1 and 6 were deemed sufficiently attractive to be considered for further study. These two alternatives have been redesignated Alternatives "B" and "A", respectively, and are fully discussed in the main text of this report. Alternatives 2 through 5 are illustrated in the accompanying figures and are briefly described as follows:

Alternative 2 – Single Pocket Turnback Station with Crossovers

This Alternative includes only a single platform and was developed as a possible least-cost alternative. However, from an operating standpoint the single pocket track obligates the operation of consecutive trains in opposite directions on the same track though the station. Fail-safe BART train control interlocking make this idea potentially feasible. Another problem is that, due to the alternation of southbound and northbound trains stopping at the platform, the headway (time between trains stopping there) would be increased and passenger convenience therefore substantially reduced. Accordingly, this would introduce an additional train control complexity. A single crossover between the mainline tracks at the south end of the pocket track is required to allow train entry into the 30th Street Station stop from the south.

Disadvantages of this Alternative far outweigh the possible cost savings and it has not received further consideration.

Alternative 3 – Single Pocket Turnback Station with Stub End Storage Track & Crossover

This Alternative requires that all trains arriving from the Eastbay which would stop at the proposed 30th Street Station, would have to turnback toward the Eastbay. The concept provides a single pocket track adjacent to the existing southbound mainline track, connected to the southbound mainline track at the north end of the station. A single crossover between the two mainline tracks would also be needed to allow turnback to the north. Alternative 3 could also be configured with a center pocket track using a "Y" connection to the mainline tracks at the north end.

This Alternative does not provide Daly City/SFO/Millbrae access from the new station, and so has been dropped from further consideration.

Alternative 4 – Two-Way Single Center Pocket Turnback Satiation with Third Level Platform

Alternative 4 consists of a two-way, single pocket track constructed between the existing mainline tracks and connected to the existing mainline tracks at each end of the station area. These track connections are configured as a 'Y' or 'wishbone' shape. Similar to Alternative 2, this alternative must operate two-way train traffic through a single station track. It would thus also require complex signal interlocking protection for fail-safe train control operations. However, the position of the new platform track between the two main tracks is preferred to that of Alternative 2 where the platform is located on one side. The primary advantage of this alternative is that it could be constructed largely within the public street right-of-way. Impacts on private right-of-way could thus be less than the two-level alternatives, which require more space outside of the existing mainline track envelope. Soil mix wall construction methods could be utilized to confine trackway construction trenching to the center of Mission Street.

This Alternative requires a two-way track so it has the same major operational and service drawbacks of Alternative 2, and therefore it has not been considered for further study. However, it was innovative and of sufficient interest so that an operational review was conducted and is described below.

Alternative 5 – Stacked Back-to-Back Center Pocket Turnback Station

This scheme has only limited merit from a geometric standpoint in that it better meets certain BART trackway design criteria. However, it is essentially a back-to-back turnback station for both directions, and does not provide for through-train movements serving the new station stop. Only turnback trains from either direction would serve the station, and all through-trains would bypass the station. This is a poor service scenario because the turnback trains would be less frequent.

There is no need presently envisioned for a southbound turnback in context with current operations planning, and therefore this Alternative has been dropped.

Operations Review of Alternative 4

Operational benefits of this Alternative include:

- The central pocket track provides operational flexibility by allowing trains to merge and diverge to/from main line tracks from both directions; with minimal conflict. Thus it is an ideal location to store disabled trains.

- If used for bypass/express operations on the center track, the double side platforms has the potential to reduce station dwells by allowing train doors to open on both sides for quicker boarding and alighting.

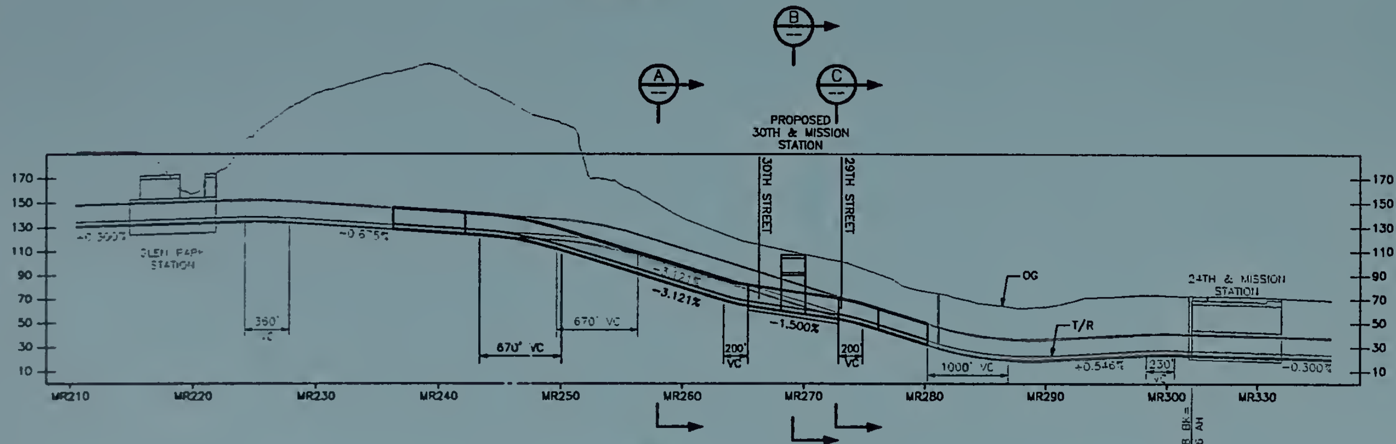
Operational drawbacks of this Alternative include:

- In the northbound direction, the steeper down grade of the new center track from 3.121 per cent to 4.0 per cent may significantly lengthen braking distances for trains.

- Because the single track and platforms must share both directions, not all trains would stop at 30th Street Station. Thus, 30th Street passengers would not receive the same level-of-service as passengers at other stations.

- Northbound and southbound trains diverted off the main line would have to alternate use of a common track, significantly reducing operational flexibility. Train sequencing and timing would be critical, adding to operational complexity.

PLAN
SCALE: NTS



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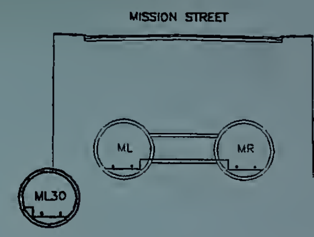
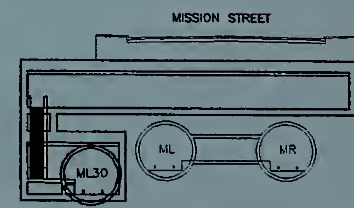
SCALE: NTS



SECTION A–A
SCALE: NTS



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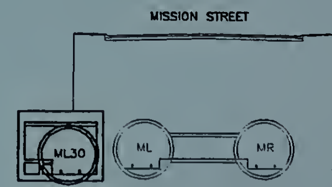
SCALE: NTS



SECTION C–C
SCALE: NTS

ALTERNATIVE 2

SINGLE POCKET TURNBACK STATION WITH CROSSOVERS

APPENDIX 'G'

30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

FOR STUDY PURPOSES ONLY

Apndx-alt-2.Dwg

ALTERNATIVE 3

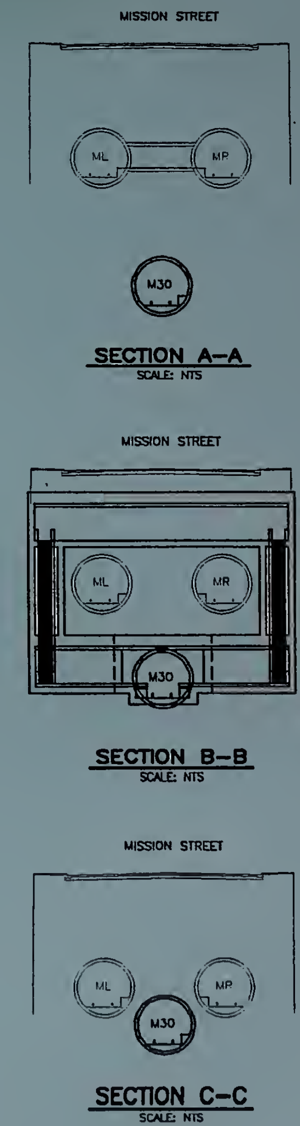
SINGLE POCKET STATION WITH STUB-END STORAGE TRACK AND CROSSOVER

APPENDIX 'G'

30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

FOR STUDY PURPOSES ONLY

Apndx-alt-3.Dwg



ALTERNATIVE 4

TWO-WAY SINGLE CENTER POCKET TURNBACK STATION WITH THIRD LEVEL PLATFORM

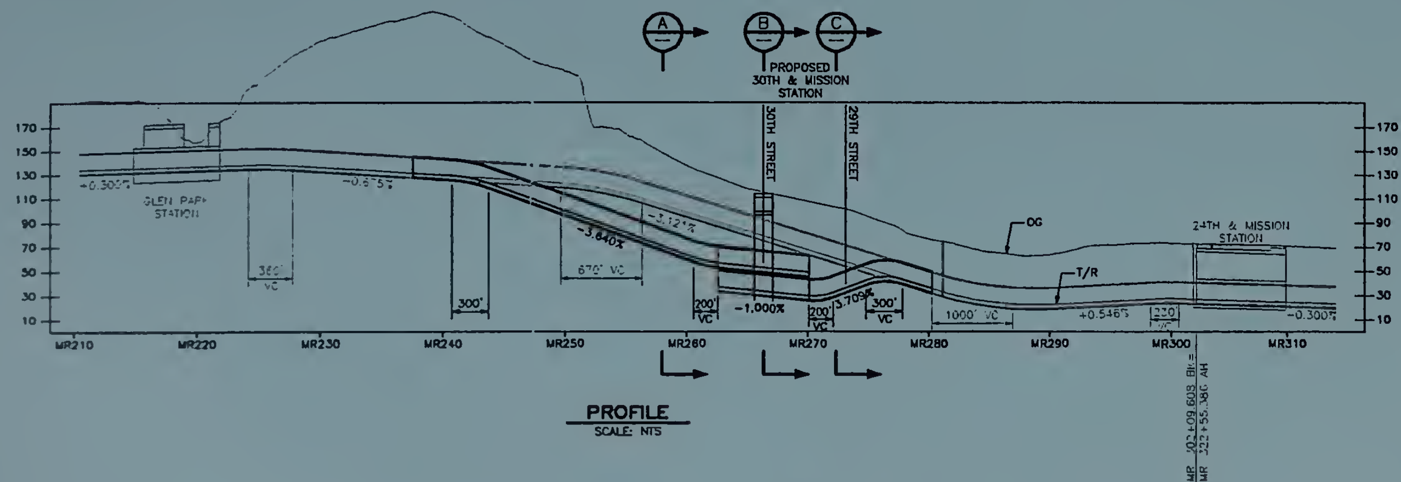
FOR STUDY PURPOSES ONLY

APPENDIX "G"

30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

Apndx-alt-4.Dwg

PLAN
SCALE: NTS



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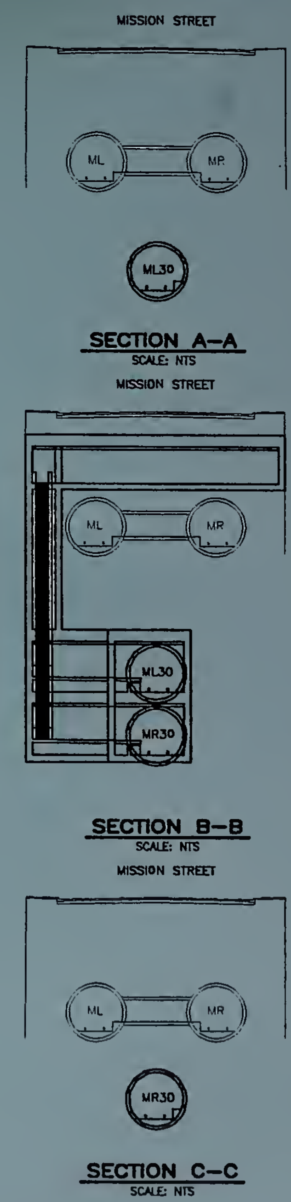


ALTERNATIVE 5
STACKED BACK-TO-BACK CENTER POCKET TURNBACK STATION

APPENDIX 'G'

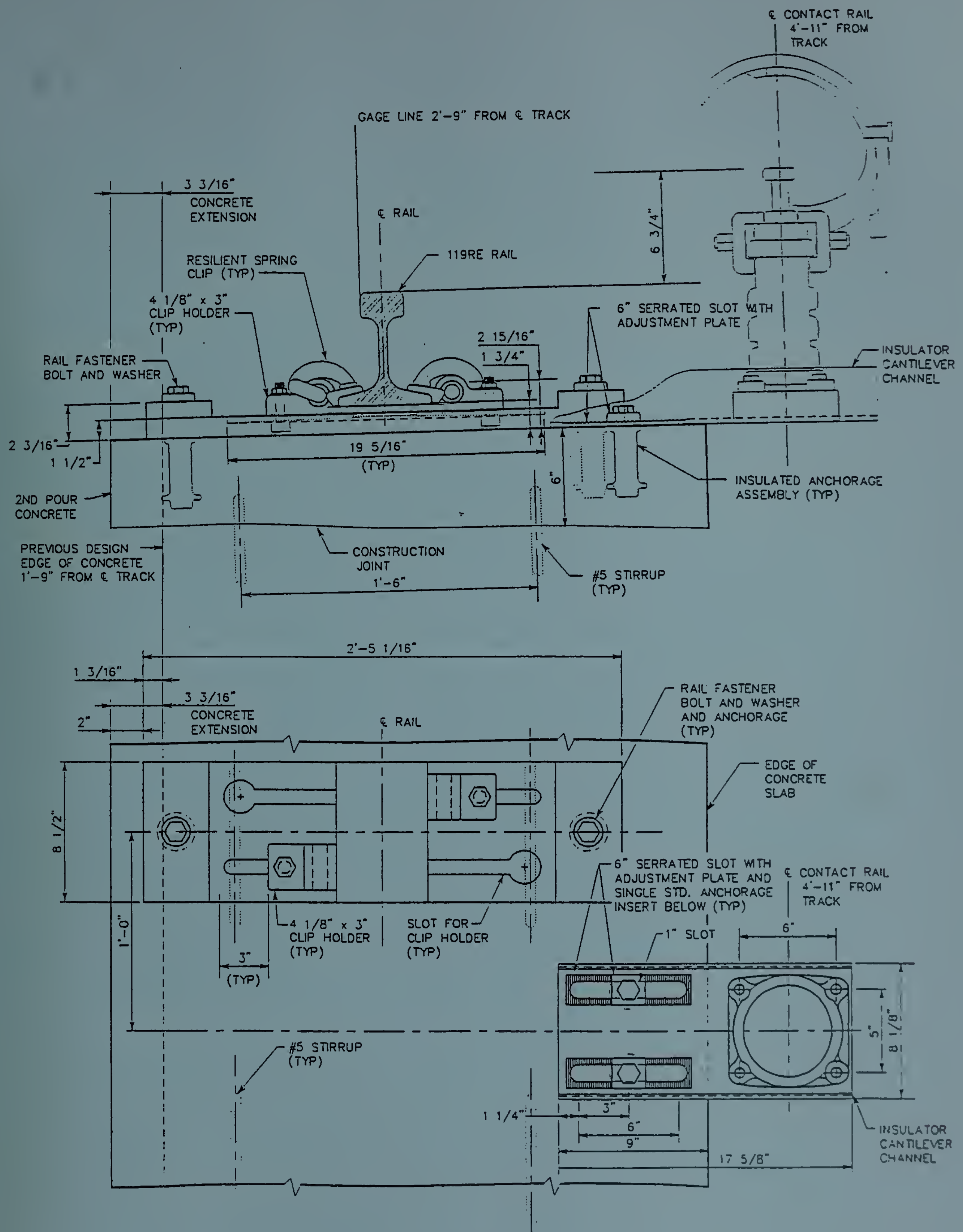
30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

FOR STUDY PURPOSES ONLY

Apndx-alt-5 Dwg

APPENDIX H

SAMPLE TRACKWORK DETAILS



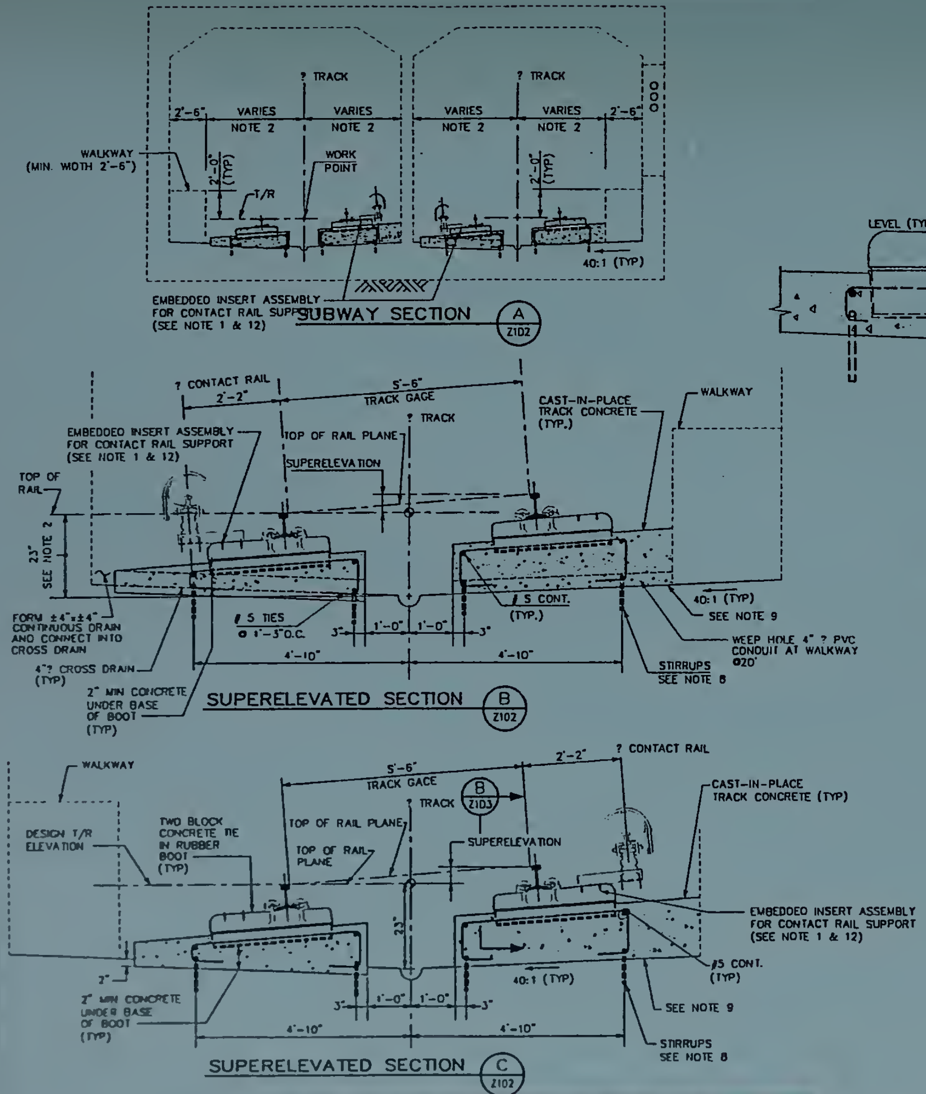
CONVENTIONAL DOUBLE SLOTTED BASE PLATE CONCEPT

EXHIBIT 3

APPENDIX 'H-1'

30TH & MISSION BART INFILL STATION STUDY

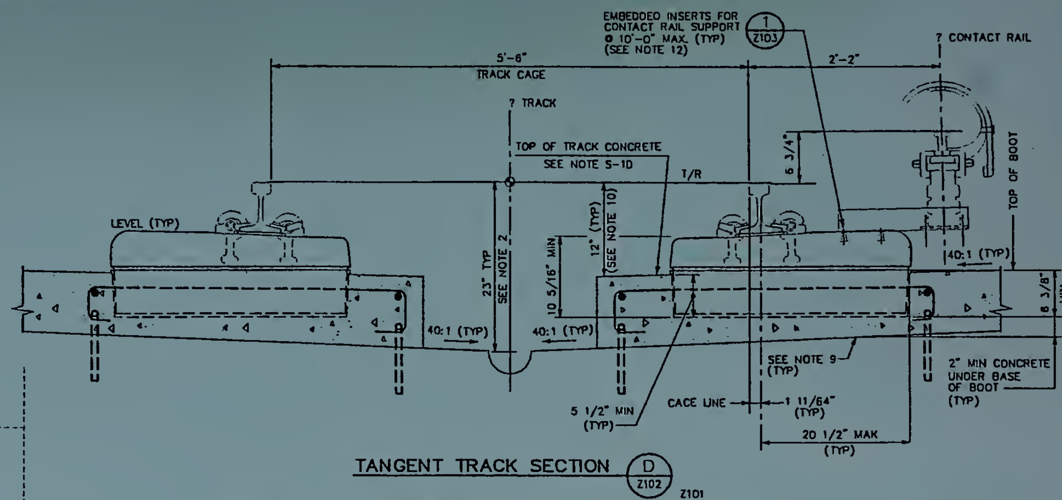
FOR STUDY PURPOSES ONLY



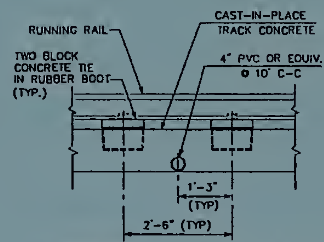
SUBWAY SECTION (A / Z102)

SUPERELEVATED SECTION (B / Z102)

SUPERELEVATED SECTION (C / Z102)



TANGENT TRACK SECTION (D / Z102) Z101



SECTION AT CROSS DRAIN OR WEEP HOLE
LOW SIDE

SECTION (E / Z102)

NOTES

1. LONGITUDINAL REINFORCEMENT SHALL TERMINATE WITH 90 DEGREE HOOK AT ALL EXPANSION JOINTS AND CONCRETE POUR ENDS.
2. THEORETICAL DESIGN DIMENSION. THESE DIMENSIONS ARE CONTROLLED BY THE TRACK ALIGNMENT AND PROFILE, BUT MAY VARY DUE TO THE EXISTING CONDITIONS. THE TRACK CONCRETE DEPTHS SHOWN ARE THEORETICAL DESIGN DEPTHS.
3. 2 INCH MINIMUM COVER ON ALL REINFORCING STEEL.
4. ROUND ALL SHARP CORNERS OF THE TRACK CONCRETE TO 3/8 INCH MINIMUM RADIUS.
5. THE TOP SURFACE OF THE APPROACH SLAB WILL MATCH THE DESIGN CROSS SLOPE OF THE TOP OF SUBGRADE OR THE TOP OF SUB-BALLAST.
6. INTERRUPT THE LONGITUDINAL STEEL FOR DRAINAGE CHASES.
7. INTERRUPT LONGITUDINAL STEEL AT BLOCK-OUTS FOR THE TRAIN CONTROL CROSS BOUND CABLE ENTRY. FOR LOCATIONS REFER TO TRAIN CONTROL DRAWINGS.
8. STIRRUPS ARE NO. 5 BARS TO FORM 10 INCH LONG STIRRUPS AT 18 INCH CENTER TO CENTER.
9. ALL SURFACES THAT SUPPORT TRACK CONCRETE SHALL BE TREATED AS A CONSTRUCTION JOINT.
10. ON RESILIENT TIE TRACK WITH SUPERELEVATION, TOP OF THE TRACK CONCRETE SHALL PARALLEL THE TOP OF RAIL PLANE. ON TANGENT TRACK, TOP OF CONCRETE SHALL SLOPE, AT 40:1 TOWARDS THE TRACK CENTERLINE.
11. THE RESILIENT TIE SHALL PROVIDE THE 1:40 SLOPE, RAIL CANT, TOWARDS THE TRACK CENTERLINE.
12. RESILIENT TIES SHALL BE CAST WITH A LEVEL BEARING SURFACE, PARALLEL TO THE TOP OF RAIL PLANE. CROSS LEVEL OF THE RAILS. AND FOUR 5/6 INCH DIAMETER INSERTS TO ATTACH CANTILEVER BRACKETS FOR THE CONTACT RAIL INSULATOR. REFER TO DRAWING NO. Z103, CONTACT RAIL SUPPORT.

NOT FOR CONSTRUCTION
DRAWING DEPICTS CONTRACT REQUIREMENTS

DESIGNED BY R. BANCHERO; DRAWN BY A. SCHRODER; CHECKED BY A. TOLENTINO; IN CHARGE K. HEILIG; DATE 12JUN97	SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	SAN FRANCISCO AIRPORT EXTENSION LINE, TRACKWORK, AND SYSTEMS
A 17JUN97 ISSUED FOR BID	BAY AREA TRANSIT CONSULTANTS (BECHTEL-PARSONS BRINCKERHOFF-TODD-WARREN) SUBMITTED ____ / BAY AREA TRANSIT CONSULTANTS (BECHTEL-PARSONS BRINCKERHOFF-TODD-WARREN) APPROVED ____	RESILIENT TIE TRACK WITHOUT TIE BAR SECTIONS AND DETAILS

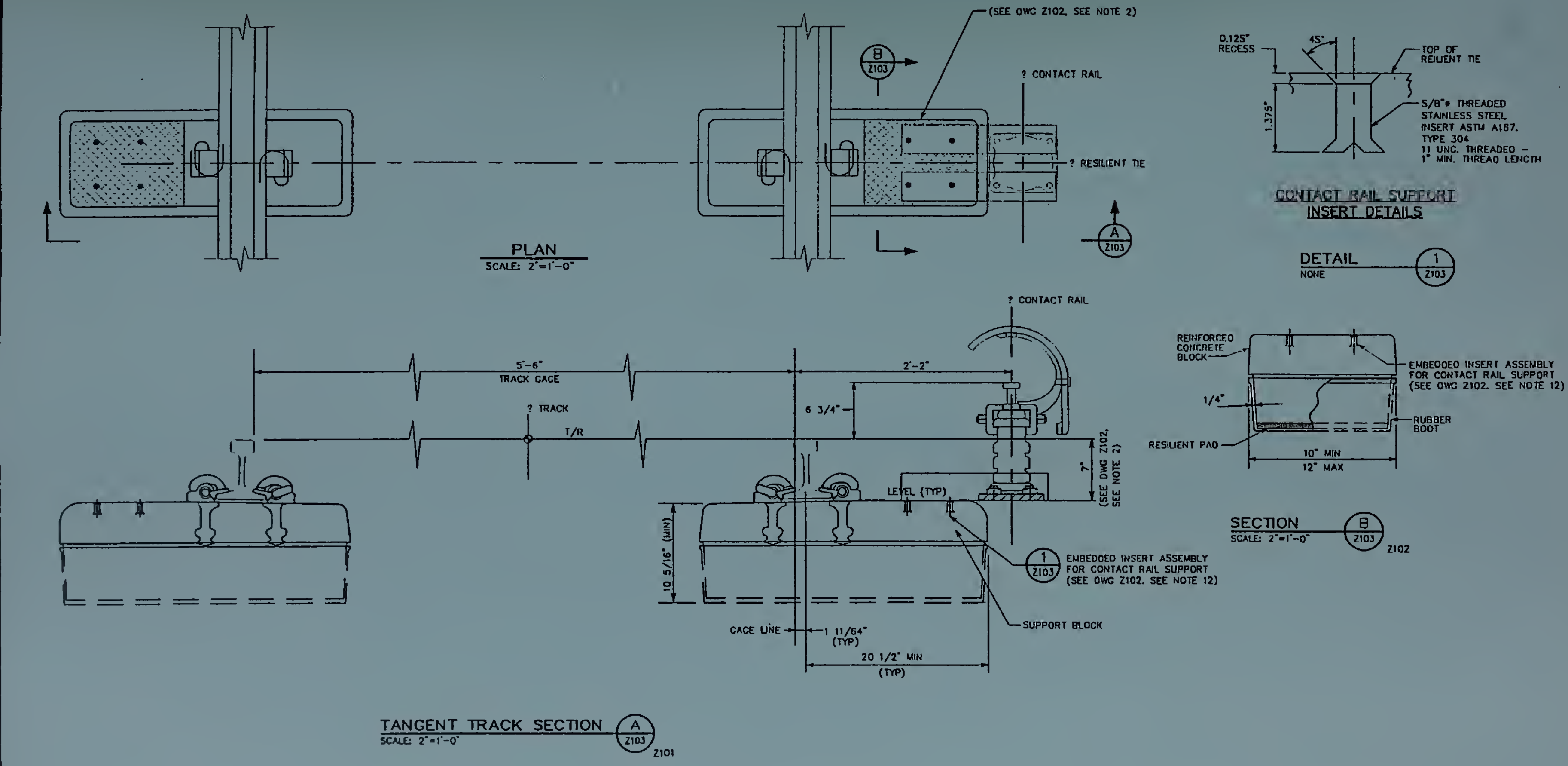
CADD FILE NO WFAAZ102 · CADD DATE 13MY97 · SCALE NONE · CONTRACT NUMBER 12YC-120 · DWG NO Z102 · REV A

APPENDIX "H-2"

30TH & MISSION BART INFILL STATION STUDY

FOR STUDY PURPOSES ONLY

Apndx-h2.Dwg



NOT FOR CONSTRUCTION
DRAWING DEPICTS CONTRACT REQUIREMENTS

DESIGNED BY	R. BANCHERO
DRAWN BY	A. SCHRODER
CHECKED BY	A. TOLENTINO
IN CHARGE	K. HOLIG
DATE	12/1/97

A | 8/1/97 | ISSUED FOR BID

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

BAY AREA TRANSIT CONSULTANTS
BECHTEL–PARSONS BRINCKERHOFF–TUDOR–WARREN
SUBMITTED

BAY AREA TRANSIT CONSULTANTS
BECHTEL–PARSONS BRINCKERHOFF–TUDOR–WARREN
APPROVED

SAN FRANCISCO AIRPORT EXTENSION LINE, TRACKWORK, AND SYSTEMS

RESILIENT TIE TRACK
WITHOUT TIE BAR
PLANS AND SECTIONS

CADD FILE NO: WFAAZ103	CADD DATE: 12MY97
SCALE: AS SHOWN	
CONTRACT NUMBER: 12YC-120	ACTIVITY CODE
DWG NO: Z103	REV: A

FOR STUDY PURPOSES ONLY

APPENDIX 'H-3'

30TH & MISSION BART INFILL STATION STUDY

Apndx-h3.Dwg

APPENDIX I

DESCRIPTION OF ADVANCED AUTOMATIC TRAIN CONTROL (AATC) SYSTEM

Reproduced from *'Railway Gazette International'*, June 2002

Top: The AATC system architecture uses a 'bucket brigade' radio network to send commands to and from the on-train computers; at any moment each train should be in contact with four lineside radios

Advanced Automatic Train Control pioneered in San Francisco

This month Bay Area Rapid Transit will put its Advanced Automatic Train Control moving block control into revenue service. Radio-based technology helps keep down installation costs in the $40m project to reduce headways and increase capacity on the busy A and M lines

FORMING PART of an upgrade of Bay Area Rapid Transit's A and M lines, the busiest routes on the 153 km network, Advanced Automatic Train Control is expected to obtain its safety case approval this month, paving the way for revenue service.

BART already handles 90 million passenger journeys a year, and in the mid-1990s projections for traffic growth suggested that BART urgently needed to increase line capacity. Critical points on the network are the Oakland Wye, used by every train on the network, and the Trans-Bay Tube. Building new lines under the Bay would cost many billions of dollars, and the search for a more cost-effective alternative fell on resignalling to permit shorter headways on the existing network.

BART began developing AATC in 1994, working with Hughes Aircraft and Morrison Knudsen Corp. At that time $19·5m of government defence conversion funding was provided to support the adaptation of Enhanced Position Location Reporting System military radio technology for civilian use. EPLRS has now been in service with the US military for over 15 years, and it is well suited for use in busy radio traffic and noisy electromagnetic environments.

AATC was installed on BART's Hayward test track, and trials were carried out for several months in 1996 (RG 7.98 p463).

Shortly afterwards, however, the launch of a pilot service on operational lines was delayed while the project alliance was restructured. Morrison Knudsen withdrew, and Hughes (later Raytheon) licensed EPLRS to Harmon Industries. Harmon was awarded a $45m development and implementation contract in 1998, with Raytheon as a subcontractor. Harmon was acquired by GE Transportation Systems, and the production version of AATC was developed by GETS Global Signaling and BART.

AATC is a full moving-block control system designed to keep installation costs low. Bob Miller, BART's Group Manager, Systems Capital Program, says AATC will cut headways and shorten end-to-end journey times, improving the ability to recover after delays and allowing BART to run its existing service with one fewer trainset. With fewer brake-to-power transitions, energy consumption will be reduced.

Technology

The backbone of AATC is a robust radio network providing data communication and radio-ranging determination of train location. AATC communicates vital location data using the radio network rather than inductive loops or balises.

Jeffrey K Baker
Product Manager
GE Transportation Systems Global Signaling

The 'brains' of the network are computers installed at stations or other convenient points. These collate location and status messages from trains, calculate train location, control speeds, generate movement authorities and control the moving blocks. The calculations can be modified from the BART control centre to enforce temporary speed restrictions or regulate traffic.

Each computer is connected to two station radios, which serve as master radios in the network. These station radios form part of a trackside network, communicating with other radios positioned alongside the railway on each side of the station. The network uses store-and-forward (bucket brigade) architecture, providing trains with multiple copies of every message for reliability.

On-train radios listen to the lineside communications, receiving messages that are outbound from the station computer and transmitting status messages back. Trains receive commands from the four closest lineside radios, so even in tunnels the

Due to start this year, Phase 3 of the project will see the installation of AATC through the Trans-Bay Tube and the Oakland Wye, providing capacity to accommodate extra services to and from San Francisco International Airport

train has multiple opportunities to hear the instructions. Use of lineside equipment permits simple, low-cost hardware to be installed on the trains.

Spread-spectrum and time division multiplexing are used to communicate with trains every 0·5 sec. Messages to trains are synchronised, and time-of-arrival measurements used to determine the location, speed and direction of each train. Head-end and tail-end radios provide redundant on-board communication and monitor train integrity and length. By updating the speed command for each train every 0·5 sec, the Station Computer provides basic Automatic Train Operation within a vital closed-loop control.

Testing in San Francisco and New York since 1999 has demonstrated message delivery reliability above 99·9%, with an ability to calculate train location to within 5 m for 99·9% of the time, and speed to within 2·5 km/h.

The plug-and-play nature of the network virtually eliminates the maintenance requirements and exacting specifications of loops and balises.

If any radio in the network fails, it is removed from the network automatically. Communication then continues normally, skipping over the failed unit until corrective action can be taken. The maintenance department is automatically alerted to the failure so that a new radio can be deployed when convenient. On power-up, the new radio joins the existing network and seamlessly begins transferring messages to and from neighbouring radios without requiring programming or special software. All radios contain the same software, so there is no need to hold an extensive range of spares.

The vital station computer calculates the location, direction and speed of each train, monitors train integrity, and sends speed and acceleration commands to all trains. The vital station computer calculates the status of fixed obstacles and the position of the rear of trains ahead in a true moving-block fashion to enforce the correct safe speed for the train.

The computers have off-the-shelf Motorola PowerPC processors, with checked-redundant architecture for safety. Diagnostic and logging functions are provided, along with local displays of the status of trains in the area. Errors in lineside or on-train equipment are reported for use in maintenance planning.

A non-vital processor can supply speed request information to the vital computer to co-ordinate the movements of trains, implementing schedule recovery or energy management algorithms. Each computer has a set of processors configured as a hot standby unit, able to take over control on the fly.

Mixed operation possible

GETS Global Signaling developed AATC to meet the requirements of the urban transport industry, rather than for a single customer. AATC can be integrated with traditional signalling and legacy on-board equipment, meaning the control system does not need to change significantly when AATC is installed.

With AATC, the only lineside installations are the radios, power supplies and station computers. Configuration and programming are automatically carried out by the system.

When new train control technology is deployed on an existing railway, phased installation can reduce disruption. AATC can overlay existing in-cab signalling, providing AATC-equipped trains with speed commands by radio and using existing track circuits to track unequipped trains. Trains enter AATC territory at line speed, seamlessly reverting to cab-signalling control as they leave.

Station computers are designed to interface to the existing signalling for tracking unequipped trains, but can also be operated as a stand-alone control system without underlying track circuits. AATC allows for operation without track circuits, but is compatible with installations requiring broken rail detection.

Not every section of a metro needs to be equipped with AATC, which can be installed incrementally according to traffic and budget constraints. Mixed-mode operation is possible, with both AATC equipped and unequipped trains operating in the same area. Instead of equipping the entire fleet with AATC technology at one time, a migration path is available for installation, with commissioning of lines and trains as the need arises. ■

San Francisco pionnier avec l'Advanced Automatic Train Control

Ce mois-ci, le Bay Area Rapid Transit met en service l'Advanced Automatic Train Control, un système de contrôle-commande avancé, destiné à améliorer la capacité sur ses deux lignes les plus chargées. L'AATC emploie la radio comme mode de transmission avec les systèmes embarqués, réduisant les coûts d'installation en comparaison avec les balises traditionnelles et circuits de voie. Mis au point par GE Transportation Systems Global Signaling, ce dispositif entièrement à cantons glissants reposant sur la radio, va rendre possible une intervalle plus courte entre les trains, des circulations plus rapides et des dépenses d'énergie maîtrisées.

San Francisco Pionier für Erweiterte Automatische Zugsicherung

Diesen Monat beginnt die Bay Area Rapid Transit mit dem Einsatz einer Erweiterten Automatischen Zugsicherung (AATC, Advanced Automatic Train Control) zur Steigerung der Kapazität auf den zwei am stärksten ausgelasteten Linien. AATC benutzt ortsfeste Funkanlagen zur Kommunikation mit fahrzeuggebundenen Systemen, was die Installationskosten im Vergleich mit herkömmlichen Balisen und Gleisstromkreisen reduziert. Das von GE Transportation Systems Global Signaling entwickelte funkbasierte Bewegliche Block-System ermöglicht kürzere Zugfolgezeiten, kürzere Reisezeiten und geringere Energiekosten

Introducción pionera del control automático avanzado del tren en San Francisco

Este mes el Bay Area Rapid Transit comenzará a usar el control automático avanzado del tren para mejorar la capacidad en su dos líneas de mayor trafico. La AATC hace uso de radios laterales para la comunicación con los sistemas del tren, reduciendo los costes de instalación en comparación con la balizas tradicionales y el circuitos de vía. Desarrollado por GE Transportation Systems Global Signaling, este sistema de control de bloque móvil completo con base en radio permitirá tiempos más cortos, trayectos más rápidos y una reducción en los costes de energía

APPENDIX J

ITEMIZED CONSTRUCTION COST ESTIMATES

SCOPE OF ESTIMATE

The work of the proposed construction would include furnishing all labor, equipment, materials and services required to construct a BART station in San Francisco at 30th and Mission Street. The station would be constructed while maintaining the BART system fully operational. The following three alternatives have been considered:

1. **Alternative 'A', On-Line Station**, including tie-ins to operating mainlines and removing/abandoning existing mainlines after the station and new mainlines are completed.
2. **Alternative 'A' With Station Pocket Track,** same as above plus constructing a new Pocket Track south of the proposed 30th Street Station.
3. **Alternative 'B' Off-Line Station**, including tie-ins to operating main lines and construction of four new number 15 turnouts and one number 15 crossover. Existing main lines would remain operational.

Each Alternative estimate is divided into the following facility groups, which could later be developed into possible contract packages:

1. Tunnels
2. Cavern (south tie in)
3. Cut and Cover Station
4. Cut and Cover (north tie in)
5. Pocket Track
6. Systems, Including Trackwork

Additional cost items for each facility and structure estimate consist of the following estimated as a percent of facility constriction:

1. Site Preparation/Demolition
2. Traffic Maintenance & Control
3. Utilities and Relocations
4. Site Restoration

5. Unforeseen construction activities (de-watering, underpinning, settlement monitoring and control, noise and vibration mitigation, etc.)

QUANTITY DEVELOPMENT

Quantification for this estimate has been developed from the drawings and sketches included in this report. Linear and lump sum quantification was used based upon BART historic costs developed for Eastbay and Southbay BART extensions contract packages and ongoing "Replacement Value Estimates" for the BART Seismic Retrofit Project.

PRICING BASIS

All unit costs in the estimates are representative of contractor bid prices at first quarter of 2002 pricing levels. Unit rates in the estimates include contractor indirect costs, mark-up and profit.

BART General Conditions:

A five per cent allowance of construction costs has been utilized to cover the following:

1. Differing site conditions
2. Partnering
3. Dispute resolution
4. Operating system access delays
5. Construction safety incentives / disincentives
6. Engineer's office, vehicles and services
7. Operation and maintenance instructions and personnel training

City Imposed Conditions:

A 10 per cent allowance of construction costs has been included in the estimate to cover costs for traffic and MUNI re-routing and restoration costs, and street and limited neighborhood upgrades after construction.

Contingencies:

A 25 per cent contingency allowance is included in the estimate. This contingency covers design, scope, construction estimating and pricing contingency up to the project completion.

Soft Costs:

The following line item costs have been included as a percentage of the total construction costs:

1.	Pre-project / Environmental studies	3%
2.	Preliminary Engineering	4%
3.	Agency administration	5%
4.	Community outreach	1%
5.	Professional services (Engineering, Project Management, & Construction Management	30%
6.	Pre-operating expenses (Start-up and Testing)	2%

Escalation:

Excluded

Schedule:

Schedule impact is not included in the estimate

Assumptions:

The following assumptions have been utilized in developing this estimate:

1. It is assumed that the contractor would be required to provide necessary insurance coverage in addition to BART OCIP insurance, and these costs are included in the unit cost rates.
2. Utilities: water, gas, power, telephone, temporary electrical power, water and other temporary utility costs would be provided by the contractor and are included in the utility allowance item. Agreements costs between utility agencies and BART are included in "soft costs" items in the estimate.
3. All property acquisitions including easements, encroachments are excluded.
4. Soil improvements around the existing operating BART tunnels are included in the estimate as a linear-measure cost allowance along the station and cut-and-cover segments.
5. It is assumed that tunnel segments could be constructed at least a tunnel-diameter width away from the existing operating tunnels, thus avoiding possible settlement in the operating tunnels, and eliminating the need for soil improvements along the tunnel segments.

Exclusions:

In addition to the above, the following are also excluded from the estimate:

1. Right-of-way costs
2. Escalation beyond 1st quarter 2002
3. Environmental and hazardous works
4. Project insurance
5. Financing and interest during construction
6. Vehicles

BART 30th Street Station @ Mission Street

ESTIMATE SUMMARY, ALTERNATE A

Description	UNIT	QUANTITY	Unit Price	AMOUNT X $1000
Tunnels	LS	1	84,235,320	84,235
Cavern @ Tie In	LS	1	21,240,000	21,240
Cut & Cover Station	LS	1	75,627,520	75,628
Cut & Cover @ Tie In	LS	1	23,577,600	23,578
Systems	LS	1	22,502,625	22,503
Sub Total				227,183
Mobilization	%	10	22,718,307	22,718
BART General Conditions	%	5	11,359,153	11,359
City Imposed Conditions	%	10	22,718,307	22,718
Sub Total, Construction Cost	LS			261,261
Contingency, (% of Construction Cost)	%	25	65,315,131	65,315
Soft Costs:(% of Construction Cost)				
Pre-Project/ Environmental Studies	%	3	7,837,816	7,838
Preliminary Engineering	%	4	10,450,421	10,450
Agency Administration	%	5	13,063,026	13,063
Community Outreach	%	1	2,612,605	2,613
Professional Services, (Eng.,PM & CM)	%	30	78,378,157	78,378
Pre-Operating Expenses, (Start Up & Testing)	%	2	5,225,210	5,225
Total Project Cost @ 2002 Dollars	LS			444,143
Right of Way Costs				
Escalation				
Environmental & Haz Mat				
Insurance				
Financing & Interest During Construction				
Vehicles				
Grand Total				

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
TUNNELS

LENGTH ______ x WIDTH ______ = AREA ______ SQ FT

DESIGN SECTION ______ QUANTITIES BY E Rasi 4/1/02 ESTIMATE NO. ______
QUANTITIES CHCKD. BY ______ DATE 4/02/02 ______ PRICED BY. ______ E. Rasi
COST INDEX ______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Bored Tunnels, 2x 2440 LF(Incl. Cross Passages)	LF	4,880	13,200	64,416,000
2	Soil Improvement, 200 LF from Station	LF	400	4,000.00	1,600,000
3	Ventilation Structure with Equipment	LS	1	2,000,000	2,000,000
4	Remove Exist Tunnels & Tracks 2x 1540 LF	LF	3,080	1,000	3,080,000
5	Abandon Exist Tunnels & Tracks 2x 900 LF	LF	1,800	500	900,000
	Sub Total Structural Items				**71,996,000**
4	Site Preparation	%	2	1,439,920	1,439,920
5	Traffic Maintenance & Control	%	3	2,159,880	2,159,880
6	Utilities & Relocations	%	1	719,960	719,960
7	Site Restoration	%	1	719,960	719,960
8	Unforeseen Construction Activities	%	10	7,199,600	7,199,600
		SUBTOTAL			84,235,320

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

30th Street Station
Cavern @ Tie In

LENGTH_______ x WIDTH_______ = AREA_______ SQ FT

DESIGN SECTION _______ QUANTITIES BY E Rasi 4/1/02 ESTIMATE NO. _______

QUANTITIES CHCKD. BY _______ DATE 4/02/02___ PRICED E E. Rasi

COST INDEX _______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Mined Cavern	LF	240	50,000	12,000,000
2	Construction Shafts,Operation & Handling	EA	2	1,000,000	2,000,000
3	Tie Ins to Mainline	EA	2	2,000,000	4,000,000
	Sub Total Structural Items				**18,000,000**
4	Site Preparation	%	2	360,000	360,000
5	Traffic Maintenance & Control	%	3	540,000	540,000
6	Utilities & Relocations	%	2	360,000	360,000
7	Site Restoration	%	1	180,000	180,000
8	Unforeseen Construction Activities	%	10	1,800,000	1,800,000
		SUBTOTAL			21,240,000

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Cut & Cover Station

LENGTH ______ x WIDTH ______ = AREA ______ SQ FT

DESIGN SECTION ______	QUANTITIES BY	E Rasi	4/1/02	ESTIMATE NO. ______	
	QUANTITIES CHCKD. BY ______		DATE 4/02/02	PRICED BY. ______	E. Rasi
				COST INDEX ______	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Cut & Cover Station, 730 ' Structure	SF	91,600	300	27,480,000
2	Soil Improvement, 1500 LF within Station	LF	1,500	4,000	6,000,000
3	Remove Existing Tunnels & Tracks within Station	LF	1,500	1,000	1,500,000
4	Station Architectural Work	SF	91,600	100	9,160,000
5	Station Mechanical Work	SF	91,600	30	2,748,000
6	Station Electrical Work	SF	91,600	60	5,496,000
7	Escalators	EA	8	750,000	6,000,000
8	Elevators	EA	2	350,000	700,000
	Sub Total				59,084,000
9	Site Preparation	%	3	1,772,520	1,772,520
10	Traffic Maintenance & Control	%	5	2,954,200	2,954,200
11	Utilities & Relocations	%	5	2,954,200	2,954,200
12	Site Restoration	%	5	2,954,200	2,954,200
13	Unforeseen Construction Activities	%	10	5,908,400	5,908,400
		SUBTOTAL			75,627,520

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Cut & Cover @ Tie in

LENGTH_______ x WIDTH_______ = AREA_______ SQ FT

DESIGN SECTION _______ | QUANTITIES BY E Rasi | 4/1/02 | ESTIMATE NO. _______

QUANTITIES CHCKD. BY _______ | DATE 4/02/02___ | PRICED BY. E. Rasi

COST INDEX _______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Cut & Cover @ Tie in Structure, 340 '	LF	340	30,000	10,200,000
2	Soil Improvement around exist. Tunnels	LF	680	4,000.00	2,720,000
3	Tie Ins to Mainline	EA	2	2,000,000.00	4,000,000
4	Remove Existing Tunnels & Tracks within Stru	LF	1,500	1,000	1,500,000
	Sub Total Structural Items				**18,420,000**
5	Site Preparation	%	3	552,600	552,600
6	Traffic Maintenance & Control	%	5	921,000	921,000
7	Utilities & Relocations	%	5	921,000	921,000
8	Site Restoration	%	5	921,000	921,000
9	Unforeseen Construction Activities	%	10	1,842,000	1,842,000
		SUBTOTAL			23,577,600

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Systems

LENGTH ______ x WIDTH ______ = AREA ______ SQ FT

DESIGN SECTION ______	QUANTITIES BY	E Rasi	4/1/02	ESTIMATE NO. ______
	QUANTITIES CHCKD. BY ______		DATE 4/02/02	PRICED BY. E. Rasi
				COST INDEX ______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Trackwork & 3rd Rail	RF	3,770	710	2,676,700
2	Trackwork & 3rd Rail Tie ins	EA	4	300,000	1,200,000
3	Traction Power	RF	3,770	440	1,658,800
4	Train Control	RF	3,770	1,200	4,524,000
5	Fare Collection	LS	1	1,000,000	1,000,000
6	Communications & Station SCADA	RF	3,770	400	1,508,000
7	Tie In to LMA	LS	1	3,000,000	3,000,000
8	Systems Tie ins to Mainline	LS	4	1,000,000	4,000,000
	Sub Total Systems Items				19,567,500
9	Site Preparation	%	1	195,675	195,675
10	Traffic Maintenance & Control	%	3	587,025	587,025
11	Utilities & Relocations	%	0	-	-
12	Site Restoration	%	1	195,675	195,675
13	Unforeseen Construction Activities	%	10	1,956,750	1,956,750
		SUBTOTAL			22,502,625

BART 30th Street Station @ Mission Street

ESTIMATE SUMMARY, ALTERNATE A (with Pocket Track)

Description	UNIT	QUANTITY	Unit Price	AMOUNT X $1000
Tunnels	LS	1	80,842,320	80,842
Pocket Track	LS	1	21,996,000	21,996
Cavern @ Tie In	LS	1	19,440,000	19,440
Cut & Cover Station	LS	1	75,627,520	75,628
Cut & Cover @ Tie In	LS	1	23,577,600	23,578
Systems	LS	1	25,862,925	25,863
Sub Total,				247,346
Mobilization	%	10	24,734,637	24,735
BART General Conditions	%	5	12,367,318	12,367
City Imposed Conditions	%	10	24,734,637	24,735
Sub Total, Construction Cost	LS			309,183
Contingency, (% of Construction Cost)	%	25	77,295,739	77,296
Soft Costs:, (% of Construction Cost)				
Pre -Project/ Environmental Studies	%	3	9,275,489	9,275
Preliminary Engineering	%	4	12,367,318	12,367
Agency Administration	%	5	15,459,148	15,459
Community Outreach	%	1	3,091,830	3,092
Professional Services,(Eng., PM & CM)	%	30	92,754,887	92,755
Pre-Operating Expenses (Start Up & Testing)	%	2	6,183,659	6,184
Total Project Cost @ 2002 Dollars	LS			525,611
Right of Way Costs				
Escalation				
Environmental & Haz Mat				
Insurance				
Financing & Interest During Construction				
Vehicles				
Grand Total				

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
TUNNELS

LENGTH______ x WIDTH______ = AREA______ SQ FT

DESIGN SECTION ______ | QUANTITIES BY E Rasi | 4/1/02 | ESTIMATE NO. ______

QUANTITIES CHCKD. BY ______ | DATE 4/02/02 | PRICED BY. E. Rasi

COST INDEX ______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Bored Tunnels, 2x 2440 LF(Incl. Cross Passages)	LF	4,880	13,200	64,416,000
2	Soil Improvement, 200 LF from Station	LF	400	4,000.00	1,600,000
3	Ventilation Structure with Equipment	LS	1	2,000,000	2,000,000
4	Remove Exist Tunnels & Tracks 2x (2440'-1900')LF	LF	1,080	1,000	1,080,000
	Sub Total Structural Items				69,096,000
5	Site Preparation	%	2	1,381,920	1,381,920
6	Traffic Maintenance & Control	%	3	2,072,880	2,072,880
7	Utilities & Relocations	%	1	690,960	690,960
8	Site Restoration	%	1	690,960	690,960
9	Unforeseen Construction Activities	%	10	6,909,600	6,909,600
		SUBTOTAL			80,842,320

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Pocket Track

LENGTH ______ x WIDTH ______ = AREA ______ SQ FT

DESIGN SECTION ______	QUANTITIES BY	E Rasi	4/1/02	ESTIMATE NO. ______			
	QUANTITIES CHCKD. BY ______		DATE 4/02/02	PRICED BY. ______	E. Rasi		
				COST INDEX ______			

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Cut & Cover Tunnel	LF	1,000	6,000	6,000,000
2	Mined Tunnel	LF	900	10,000	9,000,000
3	Remove Exist Tunnels & Tracks 2x 1900' LF	LF	3,800	1,000	3,800,000
	Sub Total Structural Items				18,800,000
4	Site Preparation	%	2	376,000	376,000
5	Traffic Maintenance & Control	%	3	564,000	564,000
6	Utilities & Relocations	%	1	188,000	188,000
7	Site Restoration	%	1	188,000	188,000
8	Unforeseen Construction Activities	%	10	1,880,000	1,880,000
		SUBTOTAL			21,996,000

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

30th Street Station
Cavern @ Tie In

LENGTH______ x WIDTH______ = AREA______ SQ FT

DESIGN SECTION ______ QUANTITIES BY E Rasi 4/1/02 ESTIMATE NO. ______

QUANTITIES CHCKD. BY ______ DATE 4/02/02___ PRICED E E. Rasi

COST INDEX ______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Mined Cavern	LF	240	50,000	12,000,000
2	Construction Shafts,Operation & Handling	EA	2	1,000,000	2,000,000
3	Tie Ins to Mainline	EA	2	2,000,000	4,000,000
	Sub Total Structural Items				18,000,000
4	Site Preparation	%	2	360,000	360,000
5	Traffic Maintenance & Control	%	3	540,000	540,000
6	Utilities & Relocations	%	2	360,000	360,000
7	Site Restoration	%	1	180,000	180,000
8	Unforeseen Construction Activities	%	10	1,800,000	1,800,000
		SUBTOTAL			19,440,000

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Cut & Cover Station

LENGTH ____ x WIDTH ____ = AREA ____ SQ FT

DESIGN SECTION ____ QUANTITIES BY E Rasi 4/1/02 ESTIMATE NO. ____
QUANTITIES CHCKD. BY ____ DATE 4/02/02 PRICED BY. ____ E. Rasi
COST INDEX ____

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Cut & Cover Station, 730 ' Structure	SF	91,600	300	27,480,000
2	Soil Improvement, 1500 LF within Station	LF	1,500	4,000	6,000,000
3	Remove Existing Tunnels & Tracks within Station	LF	1,500	1,000	1,500,000
4	Station Architectural Work	SF	91,600	100	9,160,000
5	Station Mechanical Work	SF	91,600	30	2,748,000
6	Station Electrical Work	SF	91,600	60	5,496,000
7	Escalators	EA	8	750,000	6,000,000
8	Elevators	EA	2	350,000	700,000
	Sub Total				59,084,000
9	Site Preparation	%	3	1,772,520	1,772,520
10	Traffic Maintenance & Control	%	5	2,954,200	2,954,200
11	Utilities & Relocations	%	5	2,954,200	2,954,200
12	Site Restoration	%	5	2,954,200	2,954,200
13	Unforeseen Construction Activities	%	10	5,908,400	5,908,400
		SUBTOTAL			75,627,520

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Cut & Cover @ Tie in

LENGTH_______ x WIDTH_______ = AREA_______ SQ FT

DESIGN SECTION _______	QUANTITIES BY	E Rasi	4/1/02	ESTIMATE NO. _______	
	QUANTITIES CHCKD. BY _______		DATE 4/02/02___	PRICED BY.	E. Rasi
				COST INDEX	_______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Cut & Cover @ Tie in Structure, 340 '	LF	340	30,000	10,200,000
2	Soil Improvement around exist. Tunnels	LF	680	4,000.00	2,720,000
3	Tie Ins to Mainline	EA	2	2,000,000.00	4,000,000
4	Remove Existing Tunnels & Tracks within Stru	LF	1,500	1,000	1,500,000
	Sub Total Structural Items				**18,420,000**
5	Site Preparation	%	3	552,600	552,600
6	Traffic Maintenance & Control	%	5	921,000	921,000
7	Utilities & Relocations	%	5	921,000	921,000
8	Site Restoration	%	5	921,000	921,000
9	Unforeseen Construction Activities	%	10	1,842,000	1,842,000
		SUBTOTAL			23,577,600

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Systems

LENGTH______ x WIDTH______ = AREA______ SQ FT

DESIGN SECTION ______	QUANTITIES BY	E Rasi	4/1/02	ESTIMATE NO. ______	
	QUANTITIES CHCKD. BY ______		DATE 4/02/02	PRICED BY.	E. Rasi
				COST INDEX	______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Trackwork & 3rd Rail	RF	3,770	710	2,676,700
2	Pocket Track Trackwork & 3rd Rail	LF	1,900	360	684,000
3	Pocket Track EQ Lateral Turnout	EA	1	300,000	300,000
4	Trackwork & 3rd Rail Tie ins	EA	4	300,000	1,200,000
5	Traction Power	RF	4,720	440	2,076,800
6	Train Control	RF	4,720	1,200	5,664,000
7	Communications & Station SCADA	RF	4,720	400	1,888,000
8	Fare Collection	LS	1	1,000,000	1,000,000
9	Tie In to LMA	LS	1	3,000,000	3,000,000
10	Systems Tie In to Mainline	LS	4	1,000,000	4,000,000
	Sub Total Systems Items				22,489,500
11	Site Preparation	%	1	224,895	224,895
12	Traffic Maintenance & Control	%	3	674,685	674,685
13	Utilities & Relocations	%	0	-	-
14	Site Restoration	%	1	224,895	224,895
15	Unforeseen Construction Activities	%	10	2,248,950	2,248,950
		SUBTOTAL			25,862,925

BART 30th Street Station @ Mission Street

ESTIMATE SUMMARY, ALTERNATE B

Description	UNIT	QUANTITY	Unit Price	AMOUNT X $1000
Tunnels	LS	1	79,578,720	79,579
Cavern @ 15 Turnout	LS	1	21,240,000	21,240
Cut & Cover Station	LS	1	63,107,840	63,108
Cut & Cover Turnout & Crossover Structure	LS	1	46,233,600	46,234
Systems	LS	1	25,607,625	25,608
Sub Total				235,768
Mobilization	%	10	23,576,779	23,577
BART General Conditions	%	5	11,788,389	11,788
City Imposed Conditions	%	10	23,576,779	23,577
Sub Total, Construction Cost	LS			271,133
Contingency, (% of Construction Cost)	%	25	67,783,238	67,783
Soft Costs: (% of Construction Cost)				
Pre-Project/ Environmental Studies	%	3	8,133,989	8,134
Preliminary Engineering	%	4	10,845,318	10,845
Agency Administration	%	5	13,556,648	13,557
Community Outreach	%	1	2,711,330	2,711
Professional Services, (Eng., PM & CM)	%	30	81,339,886	81,340
Pre-Operating Expenses (Start Up & Testing)	%	2	5,422,659	5,423
Total Project Cost @ 2002 Dollars	LS			460,926
Right of Way Costs				
Escalation				
Environmental & Haz Mat				
Insurance				
Financing & Interest During Construction				
Vehicles				
Grand Total				

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
TUNNELS

LENGTH______ x WIDTH______ = AREA______ SQ FT

DESIGN SECTION ______	QUANTITIES BY	E Rasi		4/1/02	ESTIMATE NO. ______		
	QUANTITIES CHCKD. BY ______			DATE 4/02/02	PRICED BY.	E. Rasi	
					COST INDEX ______		

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Bored Tunnels, 2x 2440 LF(Incl. Cross Passages)	LF	4,880	13,200	64,418,000
2	Soil Improvement, 200 LF from Station	LF	400	4,000.00	1,600,000
3	Ventilation Structure with Equipment	LS	1	2,000,000	2,000,000
	Sub Total Structural Items				**68,016,000**
4	Site Preparation	%	2	1,360,320	1,360,320
5	Traffic Maintenance & Control	%	3	2,040,480	2,040,480
6	Utilities & Relocations	%	1	680,160	680,160
7	Site Restoration	%	1	680,160	680,160
8	Unforeseen Construction Activities	%	10	6,801,600	6,801,600
		SUBTOTAL			79,578,720

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

30th Street Station
Cavern @ Turnout

LENGTH_______ x WIDTH_______ = AREA_______ SQ FT

DESIGN SECTION _______ | QUANTITIES BY E Rasi | 4/1/02 | ESTIMATE NO. _______

QUANTITIES CHCKD. BY _______ | DATE 4/02/02___ | PRICED E E. Rasi

COST INDEX _______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Mined Cavern	LF	240	50,000	12,000,000
2	Construction Shafts,Operation & Handling	EA	2	1,000,000	2,000,000
3	Tie Ins to Mainline	EA	2	2,000,000	4,000,000
	Sub Total Structural Items				**18,000,000**
4	Site Preparation	%	2	360,000	360,000
5	Traffic Maintenance & Control	%	3	540,000	540,000
6	Utilities & Relocations	%	2	360,000	360,000
7	Site Restoration	%	1	180,000	180,000
8	Unforeseen Construction Activities	%	10	1,800,000	1,800,000
		SUBTOTAL			21,240,000

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Cut & Cover Station

LENGTH ____ x WIDTH ____ = AREA ____ SQ FT

DESIGN SECTION	QUANTITIES BY	E Rasi	4/1/02	ESTIMATE NO.	
	QUANTITIES CHCKD. BY		DATE 4/02/02	PRICED BY.	E. Rasi
				COST INDEX	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Cut & Cover Station, 730 ' Structure	SF	74,700	300	22,410,000
2	Soil Improvement, 1500 LF within Station	LF	1,500	4,000	6,000,000
3	Station Architectural Work	SF	74,700	100	7,470,000
4	Station Mechanical Work	SF	74,700	30	2,241,000
5	Station Electrical Work	SF	74,700	60	4,482,000
6	Escalators	EA	8	750,000	6,000,000
7	Elevators	EA	2	350,000	700,000
	Sub Total				49,303,000
8	Site Preparation	%	3	1,479,090	1,479,090
9	Traffic Maintenance & Control	%	5	2,465,150	2,465,150
10	Utilities & Relocations	%	5	2,465,150	2,465,150
11	Site Restoration	%	5	2,465,150	2,465,150
12	Unforeseen Construction Activities	%	10	4,930,300	4,930,300
		SUBTOTAL			63,107,840

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Turnout & Crossover

LENGTH______ x WIDTH______ = AREA______ SQ FT

DESIGN SECTION ______	QUANTITIES BY	E Rasi		4/1/02	ESTIMATE NO. ______	
	QUANTITIES CHCKD. BY ______			DATE 4/02/02___	PRICED BY.	E. Rasi
					COST INDEX	______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT	
1	Cut & Cover TO & Crosover Structure, 740 '	LF	740	30,000		22,200,000
2	Soil Improvement around exist. Tunnels	LF	1,480	4,000		5,920,000
3	Tie Ins to Mainline	EA	4	2,000,000.00		8,000,000
	Sub Total Structural Items					**36,120,000**
4	Site Preparation	%	3	1,083,600		1,083,600
5	Traffic Maintenance & Control	%	5	1,806,000		1,806,000
6	Utilities & Relocations	%	5	1,806,000		1,806,000
7	Site Restoration	%	5	1,806,000		1,806,000
8	Unforeseen Construction Activities	%	10	3,612,000		3,612,000
		SUBTOTAL				**46,233,600**

BART 30th Street Station @ Mission Street

CONCEPTUAL ESTIMATE

STRUCTURE
30th Street Station
Systems

LENGTH______ x WIDTH______ = AREA______ SQ FT

DESIGN SECTION ______ QUANTITIES BY E Rasi 4/1/02 ESTIMATE NO. ______

QUANTITIES CHCKD. BY ______ DATE 4/02/02 PRICED BY. E. Rasi

COST INDEX ______

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Trackwork & 3rd Rail	RF	4,170	710	2,960,700
2	No 15 TO	EA	4	300,000	1,200,000
3	No 15 Crossover	EA	1	600,000	600,000
4	Traction Power	RF	4,170	440	1,834,800
5	Train Control	RF	4,170	1,200	5,004,000
6	Communications & Station SCADA	RF	4,170	400	1,668,000
7	Fare Collection	LS	1	1,000,000	1,000,000
8	Tie In to LMA	LS	1	3,000,000	3,000,000
9	Systems Tie In to Main Line	LS	5	1,000,000	5,000,000
	Sub Total Systems Items				**22,267,500**
10	Site Preparation	%	1	222,675	222,675
11	Traffic Maintenance & Control	%	3	668,025	668,025
12	Utilities & Relocations	%	0	-	-
13	Site Restoration	%	1	222,675	222,675
14	Unforeseen Construction Activities	%	10	2,226,750	2,226,750
		SUBTOTAL			25,607,625

PROJECT CREDITS

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